The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 14. **JULY, 1912.** **No. 127.**

PUBLISHED THE FIRST WEEK IN EACH MONTH

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of **5s.** per annum, such order to be countersigned by the superintendent or foreman.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

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Forthcoming Event.

AUGUST 6, 7, & 8.
British Foundrymen's Association—Annual Convention, to be held at Cardiff.

NOTES AND COMMENTS.

Co-Operation Between Laboratory and Foundry.

On every hand one hears of the assistance which the scientific man renders to the foundryman, and the great advances in metallurgy accomplished through scientific research; and it must be admitted that the position of metallurgy to-day is a standing tribute to the energies of the scientist. But little is said about the actual relationships existing between laboratory and, say, the foundry, so far as co-operation and mutual aid in practical working is concerned. Unfortunately, in many establishments where a laboratory forms part of the equipment, the desirable good-fellowship between the chemist and the foundry foreman is not in evidence; but rather a sense of mutual estrangement exists. Why this should be it is difficult to say; but the fact remains that often the chemist regards the foundryman as a somewhat uncertain quantity that has to be circumvented at all times, while the foundryman looks upon the chemist as an outsider who does not understand the conditions of foundry work but who is out to trip up the foundryman where possible. It is a great pity that the functions of the chemist, so far as the foundry is concerned, are not better appreciated. To act as a check on irregularities is certainly an important one of these functions, but by no means the most important. The analysis and control of the raw materials; the testing and analysis of products from the foundry; the tabulating of results in a readily-accessible form, and the reporting not only to the management but also to the foundry—these and similar duties fall to the lot of the chemist, and if carried out in a right spirit are a great help to efficient working. But if the analysis and testing of the foundry's output is simply carried out as a basis for criticism, little good can ultimately result. Take for example what might be given as a fairly typical case, particularly in non-ferrous working. The foundry turns out a product to specification, and over a long period keeps well above the requirements; but at one period (perhaps through somewhat poorer raw materials or some trifling change in practice) falls below the average, though not necessarily below specification. The chemist, noticing the lower results in the testing room, reports unfavourably on the foundry's practice, and the complaint is carried to the foreman. The latter, knowing something of the effect of position, rate of cooling, etc., on the test bars, lays himself out to give to the laboratory test-pieces that come well above the previous average, and this without altering one jot the practice as regards the castings proper. The chemist, then, seeing a sudden jump in the test results, suspects he is being "fooled," and pointedly suggests the same to the foundry; and after considerable friction the test pieces are brought back again to the old normal point, still without affecting the procedure as regards the castings which the test pieces are supposed to represent. It may be taken as a fact that the average works' chemist can be "fooled" more than a

little by a foundry foreman who knows his work: simply because the chemist is not in touch with the conditions and factors affecting the results obtained from the test pieces. Composition is only half the story, but he sometimes does not realise it. If, however, he would let the foundryman understand that while he might have to check results and report unfavourably at times, he was there to co-operate in the production of good castings, the foundryman would be more likely to impart information and make real use of the chemist's services. In very many cases the foundryman works absolutely in the dark as to the results his materials are giving. The tests are duly made, and elaborate records kept—by the party who least understands what they really represent; and until there is trouble to face, the foundryman knows nothing about the test results except that they are up to specification.

There are, of course, some concerns where the foregoing conditions do not obtain—where the foundry and laboratory work in intimate touch with each other. In such cases, great mutual benefit is derived, and excellent results are obtained with economy in materials and labour. The friction caused by lack of co-operation is not by any means conducive to successful working, and the main benefit to be derived from the laboratory is lost. Undoubtedly much of the trouble arises from the fact that the practical treatment of metals forms a comparatively small part of the chemist's training, and he does not properly realise what a number of factors, apart from composition, require to be considered. The foundry chemist should be more than an analyst—he should be a metallurgical expert as well; and this is beginning to be realised by works' managers.

Chilling Cast Iron.

In the Paper which we publish on page 412, on "Chilling and Hardening Cast Iron," by Mr. Thos. D. West (one of America's most energetic foundrymen), while much contained is already well-known, several points of interest and importance are brought out. We think that the explanation given of "inside chill" created mechanically, viz., that "the outside body of the casting cools slowly enough to allow graphite to form, while the inner body, which is not wholly solidified, is then cooled so rapidly that the carbon is held in the combined form," will be accepted as fairly obvious; though we do not recollect having seen the phenomenon previously explained on these lines. The results of some of the other experiments merely confirm the generally accepted view that the rapid conduction of heat from the cooling metal is the essential feature in producing a satisfactory chill. The experiments as to hardening by impinging air against the face of a chilled bar are interesting, as indicating that a certain "softening back" by reason of the internal heat may take place after the surface is chilled and set, and this without changing the condition of the carbon, which is, of course, in the combined form in the chilled metal. The fallacy that warm chillers are more effective than cold ones is effectively exposed, but further than that, the experiments with varying thicknesses of chillers demonstrate that the efficiency of chillers in general use is far from being in accord with their thickness. The 3-in. chiller, for example, produced but 3-16 in. more depth of chill than the 1-in. chiller. In view of the trouble which is experienced in some work through the growth of chillers after being used a few times, the suggestion regarding the use of steel for the purpose is worth some attention. The author suggests the advisability of makers of chilled rolls, car wheels, etc., trying steel chillers in place of the much heavier cast-iron ones. Steel chillers need be made only of the thickness required for efficiency in cooling and would still be strong enough to resist the contraction and expansion strains to which chillers are subjected. The liability of difficulty being encountered in using steel chillers on account of the steel warping much more than cast-iron, is certainly an objection, but probably not an insurmountable one.

The experiments to test whether, when a casting contracts away from a chiller, the depth of chill is increased by cooling the chiller, do not appeal to us as being very useful; and it is not surprising that "half a dozen tests were made without finding any practical difference in the depth or character of the chill." It should be fairly well-known that the stationary air in the gap between chiller and metal forms a heat insulation, and prevents to a great extent the egress of further heat. As regards the tests to ascertain whether a chill could be created by air under pressure when prevented by a sand coating from getting directly at the hot surface of a casting, the quest at once suggests itself as being useless. To interpose between the medium for conducting off the heat and the metal, what is known to be the most refractory material and the worst heat conductor in the foundry (the sand of the core mentioned), is obviously to prevent the air having any chilling effect worth mentioning. With the alternative, in the event of the air penetrating the sand interposed, of blowing air into molten metal, the idea will probably not be considered seriously by many foundrymen. Some slight effect in the direction of chilling was shown by conducting the air through holes close to the face of the mould, but not sufficient to suggest any practicable application of the method. The metal chiller in the form of a pipe thinly coated with sand, naturally produced a better effect, and since it remained practically in contact with the solidifying metal, air-cooling of the chiller increased that effect.

Relative Values of Air and Metal as Chillers.

A very interesting feature of the research was the ascertainment of the relative heat conductivity of moulds composed respectively of a sand body and of iron as chillers, instead of having a heat-absorbing medium impinge directly against the hot surface of the casting with exits for the rapid escape of the medium to the atmosphere. The sand was, naturally, shown to be the least effective as a conductor of heat, while the iron was not very much better when compared to the conductive power of air applied directly to the surface of the hot bar. It is not strange that a current of air absorbing the heat of the metal and passing away freely should prove more effective than a metal chiller confined in a non-conductor like sand; but at the same time the experiment indicates clearly that there is a wide field open to the use of air as a chiller. The experiments to determine the effect of chilling after the metal has solidified, too, are very interesting, indicating as they do that cooling or chilling is effective in creating or continuing a chill in a casting for a period of 20 to 30 seconds after its molten metal has solidified, and also that the formation of graphite having once taken place in the crust or body of a hot casting, no sudden cooling can restore the carbon to its original combined form. These facts are quite in keeping with the phenomena witnessed in the annealing of malleable cast iron, viz., that the separation of graphite takes place at below solidification temperature. Tests made by Mr. West further to those recorded in the abstract we publish, showed that high silicon in light-work mixtures causes the formation of graphite to take place almost immediately on solidification. Other tests

upon supposed non-chilling mixtures with silicon around 2.0 and sulphur under 0.08 showed that these percentages of silicon and sulphur marked the division between chilling and non-chilling irons of the usual good working grade of foundry mixtures.

Finally, it is suggested by Mr. West that founders and engineers interested in castings for machining, etc., might often well utilise internal chilling tests as a means of determining whether there is anything in the chemical or physical properties of mixtures likely to cause chilled edges, hard spots, etc., instead of waiting for this to be found out in the machine shop. As a standard for such tests are suggested bars 1½ in. in diameter and 6 to 8 in. long for mixtures ranging from 1.25 to 3.5 per cent. silicon and bars 2.4 in. in diameter of similar length for mixtures having from 0.5 to 1.25 per cent. silicon.

The Exhibition of Non-ferrous Metals.

On another page we give an account of the Non-ferrous Metals Exhibition which was held last month at the Royal Agricultural Hall, Islington, N., and at which some very interesting displays were made. In view of the extent to which the non-ferrous metals enter into our numerous industries, the number of firms exhibiting was somewhat disappointing. There were, however, some really excellent displays by many of the exhibitors, and a visit was not a waste of time to the technical man. Such exhibitions, naturally, suffer under the inconvenience of being displays with a purely business object, and exhibitors enter with a view to enlarging their business circle. Accordingly, many items which might figure in an educational exhibition do not appear in what is admittedly a business enterprise. The disturbed condition of the industrial world, also, probably acted as a deterrent influence in many cases. In the circumstances, then, we may accept the collection of exhibits (representing over sixty firms) as being representative of most of the important branches of the non-ferrous metals industry so far as supplies of materials go; though there was strikingly little to be seen of finished productions, either in engineering work or otherwise. We think it probable that the greater disappointment was felt by the exhibitors themselves, on account of the poor attendance of visitors, either possible customers or the general public. Either there is a striking indifference to such exhibitions, or this one was badly advertised. In the first place, the selection of London as the situation for a display of non-ferrous metals is open to criticism, for London is certainly not the centre of such industries as employ those metals. There are, of course, a number of interested firms in the London area, but only few by comparison with Birmingham and other centres; and no amount of "distinguished patronage" nowadays will induce manufacturers to travel long distances to inspect a general collection of products which may contain nothing new to them, and which, further, they may expect to have described fairly fully in the trade and technical "Press."

So far as the advertising of the Exhibition is concerned, there appears to have been room for improvement. We believe that a large number of circular letters and invitations were sent to both British and foreign manufacturers, though with somewhat poor results. So far, this class of advertising is good, but it is also necessary to place before the notice of the industrial world generally, and for some time prior to the Exhibition, announcements of the affair and its objects. The customer must be familiarised with the fact of the forthcoming event, and must be continually reminded of it and made to look forward to it. This much we think is due to the exhibitors themselves, quite apart from any other question concerned. But few people seem to have had any clear idea of the nature of the Exhibition, the date of opening or its duration. Unless the public and exhibitors alike are somewhat differently treated in future it will be hard to convince either of them that there is much to be gained by industrial exhibitions of this class. To create this impression would be a great pity, for they are without question a decided educational force and, what is more highly regarded by the manufacturer, a valuable means of getting into touch with contemporary workers and possible customers who would be difficult to approach otherwise. So far as the non-ferrous metal industry is concerned, this Exhibition should not be the last, as there is a great field to be developed in the use of many alloys which are now often regarded as curiosities. The display at Agricultural Hall last month has done something to broaden the general conception of what is being, and can be, done in non-ferrous metallurgy, but the bulk of metal users are still untouched by the appeal.

A Coke Question.

It will, perhaps, be considered out of place to offer criticism of the endeavours of practical foundrymen to solve their working problems. But we must say that the discussion on the subject of cupola coke which took place recently before the Lancashire Branch of the British Foundrymen's Association, and which we report briefly on another page, invites it. In the first place, the question "Which is the better coke to use for cupola work—heavy or light?" is rather unfortunate as a start. Surely the various discussions on coke which have been held before other Branches of the Association should have made one fact clear, viz., that lightness or heaviness alone does not constitute the requirements of a cupola coke. If it had been a question of a light or a heavy coke of a certain strength and composition, the case would have been different. But it is well known that a light coke may be high in carbon and of good strength, making it very suitable coke for the cupola, or it may be hopelessly weak and high in ash; while the same applies to heavy coke as such. As is too often the case, the discussion was started with too vague an idea in the minds of most of the members as to what the respective qualities under consideration really meant. No wonder, then, that the discussion was profitless. It would be well to start again and consider which of two cokes, one heavy and one light, and each of sufficient strength to stand the weight of the cupola charge and of approximately the same fixed carbon content, would prove the most economical and satisfactory in cupola melting. Some satisfaction may then be got.

Clydeside Tube Company, Limited.

Lord Dewar, officiating on the Bills, in the First Division of the Court of Session, at Edinburgh, has ordered intimation and advertisement of a petition presented by the Clydeside Tube Company, Limited, 41, Oswald Street, Glasgow, in which it is sought to obtain confirmation of special resolutions passed and confirmed at extraordinary general meetings of the company, by which provision is made for the substitution for one deleted of a clause to the following effect:—The capital is £175,000, divided into 175,000 ordinary shares of £1 each (of which shares 25,000 shares shall be shares already allotted as cumulative participating preference shares, and which will become ordinary shares, and 50,000 shall be ordinary shares already allotted). His Lordship also allowed parties having interest to lodge answers within eight days.

The Patterns of Gears Derived from the Helix.—II.

By Joseph Horner.

(*Continued from page* 346.)

At the present time the fashion is to bring railing accusations against worm gears which are cast from patterns. But the cost of hobbed gears is prohibitive for large sections of manufacture for which, moreover, great accuracy is not requisite. Further, unless a gear is hobbed correctly it is in no resp better than a good cast gear, and it may be worse. Again, good cast gears will very soon become worn to a perfect contact. The great value of hobbing lies chiefly in the high-speed worm reduction gears that are now so common on electric drives of all kinds, often with worms of double, treble, and even quadruple threads. The multiplication of threads increases the difficulty of pattern cutting, but not so when gears are cut in a properly designed machine in which the rotation of the hob and of the wheel are synchronised by means of change-gears.

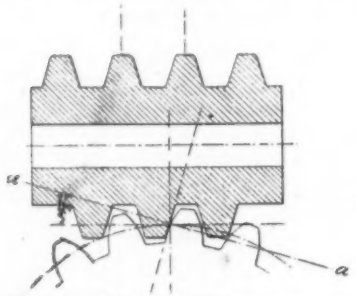


Fig. 19.—Teeth of Worm and its Wheel.

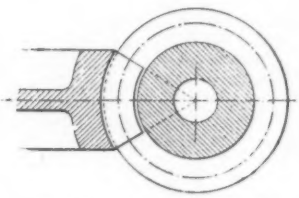


Fig. 20.—Section through Worm Gears.

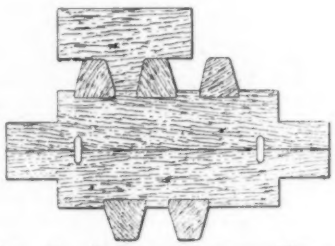


Fig. 21.—Section through Worm Pattern.

Pattern gears are rarely made with multiple threads, and single-thread gears can, as stated, be constructed with a very close approximation to perfect contact, quite sufficiently accurate for that very large class of manufacture which lies outside the high-speed electric drives, and machine-tool and certain other work. Many worm gears are moulded by machine from a block containing two or three teeth only. These have to be cut carefully, using the worm as a guide similarly to pattern wheels, but the work has to be done very well.

The elements of worm gears are shown by Figs. 19 and 20. In the first figure the worm teeth are shown of rack section, with their faces disposed at right angles to the line of pressure a—a, making a $14\frac{1}{2}$-degree angle with the tangent to the gear. The tooth shapes of the gear are obtained as stated in the previous article.* In the second figure the section of the gear is shown with its curves struck from the centre of the worm, and the ends of the teeth cut off radially.

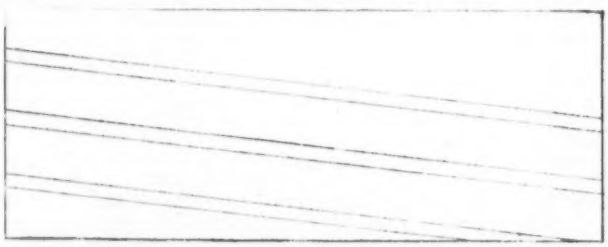


Fig. 22.—Lines for Points of Worm Thread.

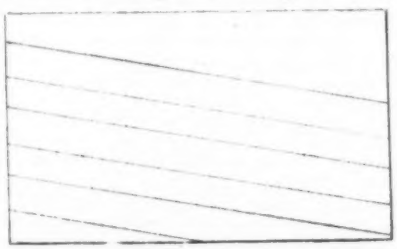


Fig. 23.—Lines for Root Grooves of Worm Thread.

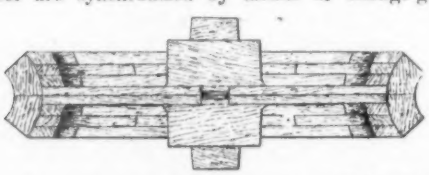


Fig. 24.—Section through Worm-Gear Pattern.

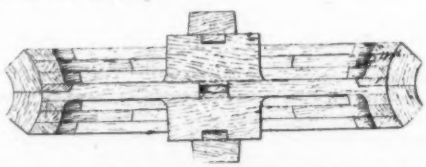


Fig. 25.—Section through Worm-Gear Pattern.

In cutting worm gears one must always commence with the worm, and it is very desirable to use the worm not only as a basis but as an actual guide

* Foundry Trade Journal, June, Page 341.

to aid in finishing the wheel teeth. The worm may be a pattern, a casting, or be machine-cut, the last being the best. A description of pattern work would not be complete unless alternative methods were offered.

FIG. 26.—TEMPLET FOR TURNING BODY OF GEAR.

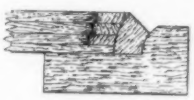


FIG. 27.—TEMPLET FOR TURNING TEETH OF GEAR.

A wooden worm pattern, when used, is jointed along the centre, and dowelled. The thread is cut (*a*) in the solid, with resulting rather short grain. Or (*b*) the pattern body is turned to the diameter of the roots of the thread, and spiral grooves are cut, into which segmental pieces are fitted with the long grain running circularly, which pieces are then cut to form the thread, Fig. 21, the latter method being preferable.

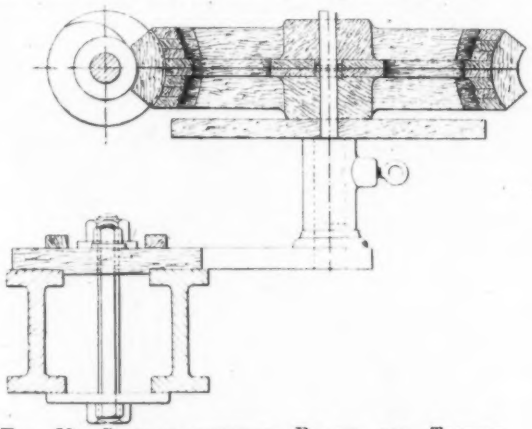


FIG. 28.—SECTION THROUGH RIG-UP FOR TESTING WORM-GEAR TEETH.

There are two ways of getting the spiral lines for the points of the thread and for its roots on the body of the pattern. Paper templets may be used, or lines of equal division. Either is correct if carefully done. When lines are drawn on paper the length of the paper equals the circumference of the part round which it is wrapped, and its width is the same as the length of the worm. The lines are drawn at the thread angle, which is that of the point when used as a guide for cutting the thread, Fig. 22, that of the root if for cutting a spiral groove for the thread segments, Fig. 23. The lines are set at a distance equal to the pitch apart, and lines parallel with these give the width of point, or root, as the case may be. If lines of intersection are employed, the circumference and the pitch are each divided into the same number of equal parts, and a line drawn through the intersections of these gives a true helix, precisely as in marking out other screws. In this case paper is not used, but the lines are drawn directly on the pattern, the circular divisions being marked from the edge of a strip of wood, and the horizontal lines round the circle being set out by dividers, and drawn parallel from the lathe bed with a surface-gauge.

The sectional shape of the thread during cutting is checked by means of a templet seen in dotted outline in Fig. 19, and repeated in Fig. 21. This work is simplified by the fact that the sides form a straight slope. If the pattern is jointed, the sectional shapes can be marked on one of the joint faces first. Though there is only a slight difference between the width of space taken parallel with the axis, or normally to the curve of the thread, a templet made for the first must not be used for the second. Two separate templets may be used, or one only. If a worm is cut carefully in this way it will be very approximately correct. An old chisel or a file may be ground to the horizontal section of the thread space, and used to take a fine scrape off the sides in the lathe after the shape has been obtained very nearly by cutting with chisel and templet. Such a pattern being moulded sideways, the joint in the casting shows, and perhaps some slight overlapping and fin, which are objectionable.

The best way to make a pattern worm is to have it cut in the lathe in iron or in brass. It is then unjointed. It may be moulded horizontally, but the better method is to mould it vertically, and screw it out of the mould through a stripping-plate, taking the weight of the pattern by a suspended rope passing over a pulley, the rig-up being similar to that

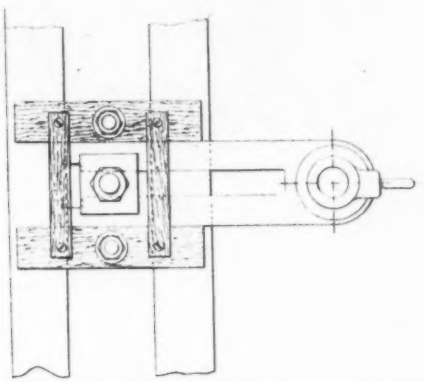


FIG. 29.—PLAN OF TOOL REST AND ITS METHOD OF CONTROL.

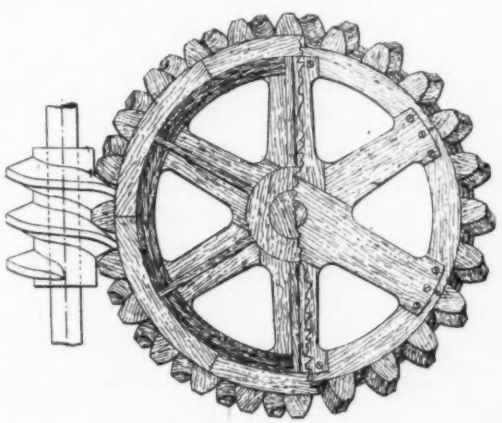


FIG. 30.—WORM WHEEL SHOWN IN EXTERNAL AND SECTIONAL VIEWS.

shown for a spiral gear in the previous article, Fig. 15. If work is not repetitive, the actual worm that meshes with a gear may be used by the pattern-maker in cutting its gear. How it or the pattern worm can be rigged up as a templet in cutting the wheel will be shown presently.

A worm-wheel pattern is built up in courses of segments on a plated centre if of small diameter, or

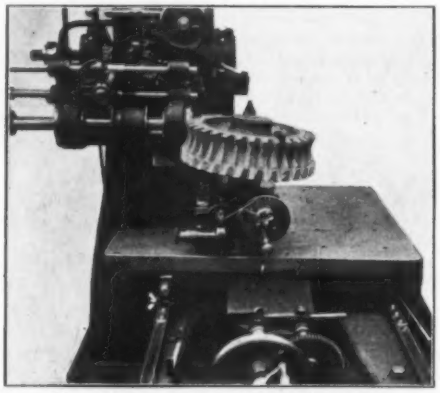


FIG. 31.—CUTTING GEAR FOR WORM-WHEEL ON WADKIN WOODWORKER.

arms are let in in most other cases, or a simple ring of teeth is made to be cast in gunmetal or in a special alloy steel, to be attached to a centre of cheaper cast iron in the case of wheels which are destined for severe service. The methods of building up are clearly shown in the drawings.

Worm wheels with straight diagonal teeth are often required of the pattern-maker. They are not

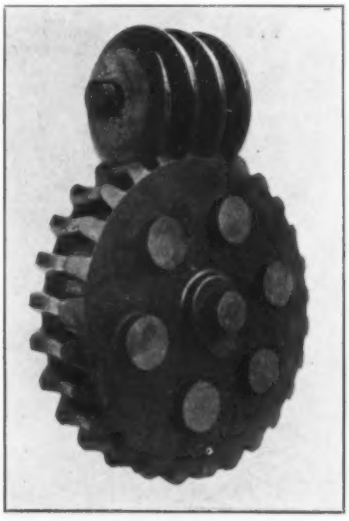


FIG. 32.—WORM AND WORM-WHEEL CUT IN 35 MINUTES ON WADKIN WOODWORKER.

bad gears, though contact with the worm does not take place away from the middle plane. The teeth are prepared as for spur gears, and glued on diagonally, corresponding with the angle of the worm thread. The patterns deliver from the sand with a kind of twist, controlled by the slope of the teeth.

All complete pattern worm wheels must be jointed along the middle plane to permit of drawing them out of the mould; and if not necessary it would be desirable, in order to obtain the centre face, to pitch out and mark the tooth shapes on. It is, perhaps, possible, though certainly not practicable, to get the shapes on the outer faces by taking sections in horizontal planes parallel with the worm sections there. Actually what is done is to mark the teeth correctly in the joint face, cut a few teeth, using the worm as a templet, just as though it were generating the wheel teeth in a machine, and then having obtained the shapes of, say, half-a-dozen teeth, pitch out the rest and find suitable curves, and mark them all out on the outside. Then they are easily set in and cut with gouge and chisel, and the curves of the tooth points from these faces to the faces on the central plane are marked approximately from the edge of a bit of clock spring. After cutting by these guides, a very little correction, using the worm as a templet, ensures practically correct teeth. Because the teeth become unsymmetrical on the outer faces, and the more so the greater the angle of the worm thread, the shapes can only be

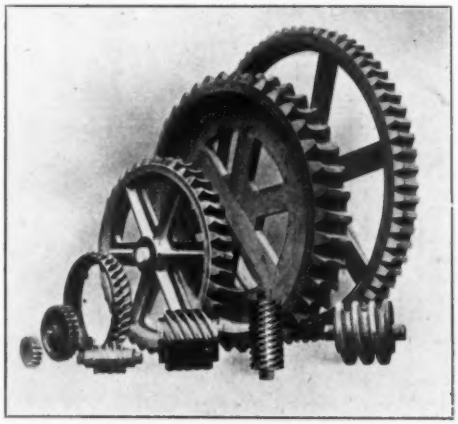


FIG. 33.—GROUP OF GEARS.

obtained by using the worm in the fashion of a generating hob. But the shapes of the teeth in the central plane are symmetrical, and differ in no respect from those of spur gears of similar dimensions. A section through the middle plane, as in Fig. 19, shows the relations of the worm and its wheel, the first having teeth of rack section, the second involutes. All the proportions are those of ordinary involutes. But circular pitches are generally used in pattern work in preference to diametral pitches.

When the rim is built up in halves it is jointed either through the central plane, Fig. 24, of the web, or the arms, as the case may be, or the plate or arms are left undivided, and the upper part of the rim only is registered to the lower, Fig. 25. At this stage the concavity or throat of the rim which corresponds with the roots of the teeth is turned to templet, Fig. 26, the latter being set against the joint faces of the pattern halves. In this concavity the blocks for the teeth are fitted and glued, with sufficient allowances for turning off faces and points, Fig. 27, and for cutting the flanks.

In turning these blocks it is not necessary to fit and glue filling-in pieces between each block at the ends to prevent the end grain from being torn out in turning. It is sometimes done, but a sharp gouge taking light cuts will not tear out the grain much,

if the leading side of each block is chamfered off first. Sometimes blocks are fitted in widths sufficient to take three or four teeth each. But this is tedious, and the tooth spaces have to be cut through with saw and gouge.

Accurate contact can only be ensured by rigging up a piece of apparatus, Figs. 28 and 29, which will resemble that used for hobbing. The worm and wheel must be mounted with their axes in their proper relations, with provision for an inward rectilinear adjustment of the wheel towards the worm. Worm and wheel must be free to revolve. The most convenient way to rig this up is in a lathe, the worm between centres, and the wheel on a pin held in the socket of the tee-rest, and the socket being coerced with side strips on the lathe bed.

Fig. 30 gives the appearance of a finished pattern in part external and part sectional views. Figs. 31 to 33 illustrate examples of machine-cut work. Fig. 31 is a gear being cut in one of the Wadkin machines by the aid of a dividing head and change-gears. Fig. 32 is the worm and its gear. The two were cut in 35 minutes. Fig. 33 is a small group of such gears cut by Messrs. David Brown & Sons, Limited, of Huddersfield.

Heat Insulation in Furnaces.

At the meeting of the American Electro-Chemical Society held in Boston, U.S.A., recently, a Paper read by Mr. F. A. J. Fitz Gerald, of the Fitz Gerald and Bennie Laboratories, of Niagara Falls, N.Y., gave a preliminary account of an experimental investigation of different heat-insulating materials as to their relative suitability for furnace insulation. Throughout the experiments the insulating material used was in the form of bricks, the furnace being always built up from the bricks in the same way. The furnace was closed and heated electrically from the inside by a nichrome resistance wire. By means of a rheostat the current through the resistance wire, and therefore the temperature, could be regulated.

Readings were taken when for a given current a definite temperature had been reached in the furnace and remained perfectly constant. The rate of generation of energy in the resister was then determined, and this gave the rate at which heat was escaping through the surface walls, neglecting what escaped by conduction through the leads going to the resister and through the wires of the pyrometer thermocouple. From the data obtained in this way curves were plotted (see annexed diagram) in which the abscissæ were temperatures and the ordinates watts.

Curve 2 is a firebrick of moderately good quality, and not of any special make.

Curve 4 is for a silica brick. In spite of its low heat conductivity, this particular silica brick is not a satisfactory insulator. The maximum temperature reached with the silica brick was 670 deg. The heat loss here was 36 per cent. greater than with the firebrick. It is not very safe to theorise as to the cause of this phenomenon, but it looks as though the radiation from the surface of the silica brick is very much greater than from the ordinary firebrick.

Curve 6 was obtained from an alundum brick, a highly refractory one. The transmission of heat was so rapid with this brick that the maximum temperature obtained in the furnace was only 570 deg. This illustrates well the value of such alundum refractories as crucibles, muffles, etc., where it is desirable to have as efficient transmission of heat as possible.

Curve 7 relates to a brick made of silicon carbide. The brick is pure silicon carbide, that is, no bond is used in making it. The transmission of heat is extremely good with this brick, so that the maximum of temperature reached in the furnace was only 420 deg.

Curve 9 is that for an ordinary red building brick of the cheapest kind. It is seen to be the best insulator of any of this lot, the heat losses being as much as 34 per cent. less than those for the firebrick (2) at a temperature of 800 deg.

Curve 10 shows the results obtained with a magnesia brick. This was of a standard kind made of brown magnesia.

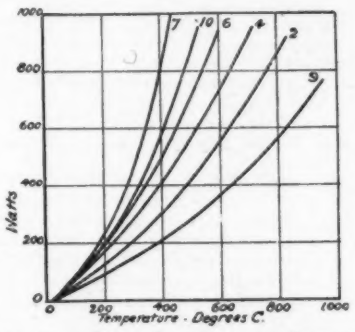


Diagram of Heat Losses with Different Refractories.

In another experiment the furnace was built first with the ordinary firebrick (No. 2), and afterwards the same furnace was entirely covered with a 1 in. thickness of a special heat-insulating material. This reduced the heat losses by more than 50 per cent.

A further experiment showed that the use of a special insulating brick instead of ordinary firebrick reduced the heat losses by 68 per cent.

The question of suitable representation of English manufacturers on the Canadian markets, in consequence of the competition experienced from American and other sources, has always been considered a vital one in this country. In connection with this matter, Mr. Leonard Andrews spent some months in Canada during the summer of 1910, and again last year, making investigations as to the prospects of securing the greater part of the trade of the country on behalf of a number of British manufacturers of engineering appliances. Mr. Andrews' conclusions are that, to overcome the prevailing difficulties, those interested in the matter, both in this country and Canada, should organise a corporate body, in connection with which it would be possible to utilise the combined advantages of the local knowledge and connection of the Canadian agents with the technical knowledge of the manufacturers' own experts. The proposed corporation would not be financed by the manufacturers interested, and would, therefore, be in a position to act as principals, both with regard to the buyers and sellers. There would be a London office and engineering staff, through whom all negotiations with manufacturers would pass, and a head Canadian office, with branch offices in the principal cities throughout the Dominion. The Canadian offices would be controlled by Canadian business men and engineers, supported by a staff of Canadian salesmen distributed over the entire country. The latter would keep the branch offices, and through them the head Canadian office and London office advised of all engineering developments, and would carry out a general educational campaign in favour of British engineering practice. They would endeavour to persuade Canadian buyers to pay a visit of inspection to some of the leading engineering works in this country. In this connection it is interesting to learn that Mr. Andrews has already received the support of many well-known British manufacturers.

Die Castings.*

By Amasa Trowbridge.

The art of die casting, that is, the making of castings in steel moulds to finished size and shape, was first introduced in connection with the manufacture of type. Such machines were attempted early in the 19th century and by the close of that century the perfected linotype and monotype machines which are fine examples of die-casting machines, had been evolved. Machines for casting individual pieces of type are also still in use and the most recent ones will cast about 125 to 150 pieces per minute. This gives some idea of the speed with which such castings can be made

When the casting type was perfected, it saved so much time that its usefulness for making other pieces which were wanted in large quantities was at once evident. Accordingly many men have made efforts to perfect a machine or process by which they could turn out finished castings correct as to size and shape. So far no material superior to steel, the material used for type moulds, has been found for making the matrices, or dies, as they are called. Brass can be and is used where the casting is very intermittent, as in a linotype machine, but for continuous work and where accuracy is required, steel is necessary.

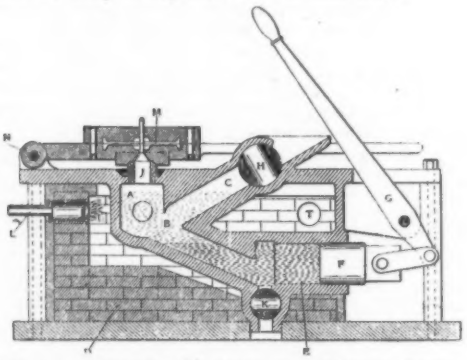


FIG. 1.—MOULDING MACHINE WITH MOULD LYING FLAT ON TOP.

There are only a few common metals with a melting point sufficiently low to be cast in steel dies, because these do not have to be brought to their melting point to be spoiled. If improperly treated in making, the dies are very susceptible to injury in use. Fine cracks are sometimes made in hardening the dies, causing them to break when subjected to the constant change of temperature which occurs in their use. Thin places in dies are more apt to get burned than heavy parts. For most work hardened dies are superior to soft, but their cost is very much greater.

In general, the method of making a casting is as follows:—A suitable die or mould is made in steel. This must be so arranged that when opened, the casting will either drop out or be easily ejected. The die should have the fewest possible partings. This is important, because it is easier to hold the casting to correct size when the die is in a few pieces than when it is in many. Also, the fewer the partings, the fewer the fins that will be made on the castings. Whenever cores are necessary, suitable means must be provided for withdrawing these without deforming the casting. The die must close properly, that is, in correct alignment, and be held firmly because the pressure of the fluid metal has to be overcome. The die being held closed in the machine, metal is forced into the die, pressure being provided by a pump which acts directly on the metal, by air pressure on top of the molten metal or by a head of molten metal. The metal is allowed only to set. The mould is then opened and the casting removed, the casting being left in the mould only as long as is absolutely necessary. If the die is too hot, it is then cooled and the operation repeated. The temperature of the die is important, and should be held constant because the expansion of the die will change the size of the casting. This operation is generally carried on in so-called hand-casting machines, that is, machines operated by manual labour.

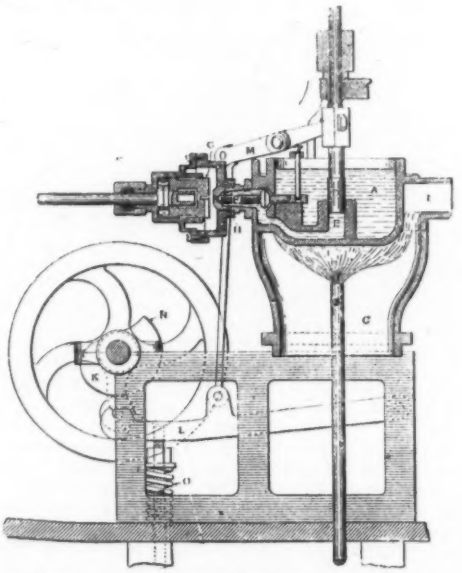


FIG. 2.—AUTOMATIC MOULDING MACHINE.

Automatic machines are in use and have great advantages in producing uniform castings because the conditions do not vary. The automatic machine is run at a constant speed and is not subject to varying conditions due to the operator becoming tired. Hand-casting machines produce quantities of 500 per day, more or less, depending on the size and complexity of the piece. Automatic machines produce the castings much more rapidly and save on labour just as does any other type of machinery.

While the writer has been able to find only one maker of casting machines who is willing to publish a description of them, a few illustrations are given to indicate the form of machine that is used, and it might be well to say that these actually show only the principles involved in each machine rather than the perfected mechanism.

Fig. 1 shows a machine in which the metal is pumped into the mould by hand. A is the hot molten metal; C the charging chute; H a valve to close this;

* Abstract of Paper read before the American Society of Mechanical Engineers, and printed in the "Proceedings" of the Society.

E the pump cylinder; F the plunger; G the pump lever; J the nozzle through which metal is forced into the mould M; K a valve for emptying the metal pot B. The gas for heat is supplied through pipe L. and the waste gases escape at T.

Fig. 2 shows an automatic machine. A is the molten metal; B the gas pipe; D the pump plunger; E the pump cylinder; F a valve to close the passage between the pump chamber and the metal pot, while metal is forced through the nozzle into the die or mould G, which is brought up tightly against the nozzle while the metal is forced in. The left end of F closes the nozzle, while metal is drawn into the pump chamber by the raising of the plunger D.

Fig. 3 shows a hand machine in which air pressure is used to force the metal into the mould. Air enters at A and is controlled by the valve B. It comes down through the vertical pipe C and exerts a pressure on the loose piston D. This piston is hollow and floats on the metal contained in the pump chamber E. Metal is admitted to this chamber E from the main metal pot F through the Valve G. The metal is forced by the pressure of the piston D out of the nozzle H into the mould J. The use of the piston D prevents oxidation of the metal from contact with the air which is admitted to force the metal into the mould. This air pressure is released before the valve G is opened, so that metal can flow by gravity into the pump chamber. The metal which is forced

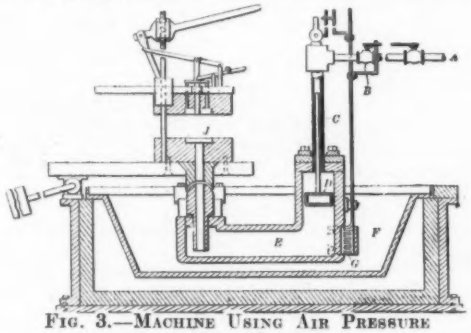


FIG. 3.—MACHINE USING AIR PRESSURE TO FILL MOULD.

directly into the mould is taken from below the top surface of the molten metal and this precludes the oxidised skin on top of the metal from being forced into the dies. Any of this oxidised metal would make bad castings, so that this point is important. The entire pump chamber in this arrangement is submerged in molten metal, so that it is kept hot. The nozzle is so situated that it is probable extra means would have to be used to keep it heated and prevent the metal from freezing at this point. Undoubtedly in the practical working out of the machine this point was cared for.

The feature about die castings which most appeals to the manufacturer is their accuracy. So long as the dies are in good condition, the castings should be perfectly true, both in size and shape. This does away with the necessity of gauging and makes it possible to use them without their having to be fitted into place by any hand work. A careful inspection is necessary, and this should be done as soon as possible after the castings are made so as to detect any flaws due to a slight failure of the dies. Any fins or burrs formed by the necessary joints in the dies can be removed at the same time that the castings are inspected. Usually these fins are not thick and can be taken off thoroughly and quickly with a light hand tool.

A difficulty due to shrinkage is sometimes encountered when these castings are to be used in connection with parts made by some other process. While the shrinkage will be the same in two castings made in the same die if the metal is properly handled, it does not always follow that it is proportionately the same when they are made from different moulds. It is affected to a marked degree by the form of the casting, and if the castings are to be used in connection with machined pieces, it is advisable that these be machined to fit the casting. When it is not possible to do this and the casting must be fitted to existing pieces, sample castings should be made, and if these are not correct, the dies can be altered to make castings that are correct. In doing this, sufficient material must be allowed for grinding away, the casting being at first too small, although this makes a great deal of extra work.

The greatest gain obtains when an entire machine can be made of such castings. One of the best examples of this is the Veeder cyclometer so largely used on bicycles. This instrument is composed of about a dozen die castings and nearly as many parts of other materials. The number rings have 0.001 in. play, and yet these castings are made in enormous lots and, without being gauged, are assembled into the die-cast cases where they fit and work properly. So exact are these castings that, when new, the instruments work more easily without lubrication than with it. This would obviously be possible only where the clearances are extremely small. A small dimension on these castings can be maintained to 0.0001 in. This

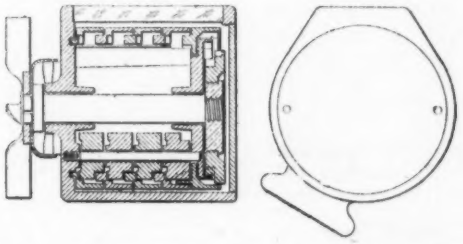


FIG. 4.—VEEDER CYCLOMETER WITH SECTIONAL VIEW.

instrument is illustrated in Fig. 4, the section view showing the rings both in their relation to the hub on which they turn and in contact with the transfer pinions. These latter turn on a German silver shaft 0.04 in. in diameter. The hub which forms the bearing for the number rings is so large in proportion to the width of these that they would tip and cramp if much end play were allowed. This makes it necessary to hold the dimensions on the rings correct within less than one-half of 0.001 in.

The quality of these castings depends on both the alloy used and the method of making them. The alloys in most common use are those having a zinc base. This metal is useful in certain alloys, particularly with copper, but if alloyed with aluminium is unsuitable for most purposes. Aluminium-zinc alloys are frequently used because aluminium makes the alloy lighter in weight and in colour. Some time after manufacture, castings of this alloy begin to disintegrate and will actually fall to pieces. In the disintegrating process they also change shape badly, so that they should never under any circumstances be used for pieces which are wanted to stay flat and true. This alloy also tarnishes rapidly. Most of the alloys of zinc are too brittle to be of much use for the making of die castings. The usual effect of casting in metal moulds is to make harder castings than would be made from the same metal in sand moulds. For this reason a fairly ductile metal should be used.

The alloys of tin are being used quite extensively for die castings. The alloys possess the two desirable

qualities of being quite ductile and of melting at a low temperature. Genuine babbitt metal, as it is commonly called, is an alloy consisting, according to the best authorities, of about 89 per cent. tin, 7.3 per cent. antimony and 3.7 per cent. copper. This is a remarkably fine bearing metal and is possessed of sufficient strength to make it useful for many small parts. By certain changes in the alloy a composition even better for ordinary die-casting use can be produced.

The alloys of lead are used to a limited extent but, except for type, this metal is more often used in small proportions than as the foundation of the alloy. It is too heavy and lacks sufficient strength to make a very desirable metal. The percentage of lead in an alloy is sometimes increased for the sake of lowering the melting point and the price per pound.

Antimony is a common constituent of all die-casting alloys. The addition of this metal in the proper proportions makes the alloy hard enough to machine well and increases the fluidity of the metal in its molten state. This makes it possible to obtain sharp castings such as are made from type metal, which is an alloy consisting of lead, 87½ per cent., and antimony, 12½ per cent.

In making an alloy of any two metals, when they are in correct proportions, there is formed an eutectic, the melting point of which is lower than that of either of the constituent metals. In some cases, by the addition of a third metal, the melting point may be still further lowered.

FIG. 5.—INTERNAL GEAR.

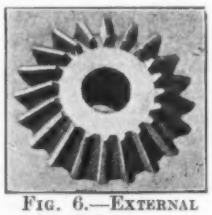


FIG. 6.—EXTERNAL GEAR.

The strength of the die castings is, of course, largely dependent on the alloy, and also on the method of casting. Unless proper precautions are taken to insure sound castings, much trouble will be encountered from blow holes. To prevent these is often very difficult and sometimes impossible. They are caused both by the form of casting, and by the tendency of the molten metal to hold minute bubbles of air or other gases which are carried into the mould and do not escape before the casting sets. This is a case exactly parallel to that found in making iron castings. The shrinkage of the ordinary die casting is not as great as that of cast iron, and some of the tin alloys particularly shrink scarcely at all.

Another similarity to iron moulding is found in the fact that the outside skin of the die casting is ordinarily stronger and harder than its interior. The hard outside skin is always desirable on a die casting, because the piece being cast to its finished size and no cutting being required, it is this outside skin which is first subjected to wear.

Exact figures on the strength of die castings might be quite misleading unless the exact composition and treatment of the castings were noted, so that general figures only can be given. They compare very favourably with cast iron in tensile strength, but are not nearly so strong in compression as that material. Their compressive strength is usually but little greater than the tensile, although it is somewhat, say one-third, greater. As the material is not as brittle as cast iron, it can be subjected to shocks which the iron would not withstand. Most die castings are much more ductile than cast iron. The greater ductility of the die castings is an advantage for threaded or tapped pieces. The castings do not chip out when tapped near an edge and a fine thread may be used. Some of the alloys are so ductile that the castings may be spun or riveted. This is often needed, or is convenient for fastening two castings together or fastening a casting and some other piece.

Very little idea can be given of the cost of parts manufactured by the die-cast method. The tools or dies are costly or otherwise, according to their complexity or their simplicity. Practically all the die-casting manufacturers make the customer who ordered the castings pay for the die. The parts are then charged for according to the time needed to cast them and the amount of metal used. As only the metal in the finished casting is charged for, there is no expense for scrap. The time for casting a complicated piece is little, if any, greater than for a simple one. From this it follows that the more complicated the casting, or the more difficult it would be to machine, the greater will be the saving effected by the use of die castings. The number of pieces to be made from a die is also pertinent, for hundreds of thousands of pieces can be made from some dies with no injury whatever to them. Other dies may need frequent repair due to unavoidably weak points in their construction. Number wheels having internal or hooded gear teeth are good examples of parts which are profitably made by this process.

The necessary die for the internal and external gears shown in Figs. 5 and 6 would cost about £20 for a hand-casting machine, and the castings about 6½d. each in 10,000 lots. The dies for the same piece to be used in an automatic machine would cost about £90, and the castings would cost about 1d. each in 10,000 lots, plus 4d. to 4½d. each for metal. The bevel gear illustrated was made in a hand-operated machine, of a zinc alloy, commonly known as hard metal. A die for this costs about £18, and the castings 3¾d. each in 1,000 lots, and 3½d. each in 10,000 lots.

The Pittsburg Foundrymen's Association.

The annual meeting of the Pittsburg Foundrymen's Association was held at Pittsburg on June 3. In the absence of the President, S. R. Sleeth, of the Westinghouse Air Brake Company, Wilmerding, Pa., occupied the chair. The report of the treasurer for the year was read, showing a balance on hand June 1 of $810.87. The report of the secretary showed that the Association now has a membership of 157, of which five are honorary members. The Paper of the evening was entitled "Brass Mixtures," and was presented by William H. Wood, foreman of the brass shops of the Pennsylvania Lines West, Pittsburg.

The election of officers to serve for the year beginning June 1 was held and resulted as follows:—William A. Bole, Westinghouse Machine Company, East Pittsburg, President; H. W. Petty, American Steel Foundries, Vice-President; F. H. Zimmers, Union Foundry and Machine Company, Pittsburg, Secretary; and William J. Brant, Treasurer. An Executive Committee was elected as follows:—H. M. Wilson, Taylor-Wilson Manufacturing Company; George W. Knotts, United Engineering and Foundry Company; John A. Logan, Jones & Laughlin Steel Company; James R. Darragh, Rogers, Brown & Company, and W. J. Phillips, Phillips & McLaren, all of Pittsburg.

MR. ROBERT H. LASCH, for many years partner in the firm of Selig, Sonnenthal & Company, and latterly chairman and managing director of the Selson Engineering Company, Limited, London, has resigned and severed his connection with the company. He is succeeded by Mr. H. M. Sonnenthal.

The Use of Electricity in the Metallographic Laboratory.

One of the most recent fields of research in iron and steel manufacture is the examination of the micro-structure of test specimens, and the laboratory of the up-to-date iron and steel manufacturer can hardly be considered complete without the presence of a metallurgical microscope and its accessories. The examination of such structures may be conducted either purely optically, or if a permanent record is desired, a micro-photograph of the object may be taken as viewed through the microscope, and this preserved for future reference.

Both for optical and photographic work, a strong light is necessary, thrown either directly on to the surface of the specimen, or obliquely so as to obtain the required angle of incidence of light for any particular object. In this electricity fulfils an important function, while it also occupies various other spheres of usefulness in the metallographic laboratory. It will, therefore, be useful to consider briefly some of the applications of electricity in this particular sphere of work.

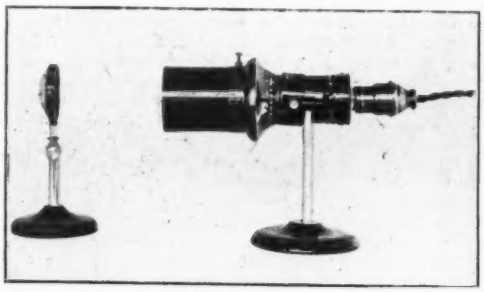


FIG. 1.

One of the most obvious methods of obtaining the necessary light for examination of the specimen under the microscope is, of course, the use of the incandescent electric lamp. It should be mounted on a stand having a vertical support to which the lamp can be clamped at varying heights. The lamp itself is held in a vertical position, and should preferably be not less than 100 candle-power, and be furnished with a switch. The chief objection to such a lamp is that the filaments are necessarily fragile and liable to break, and to guard against this it is advisable, for portable lighting of this description, to adhere to low-voltage lamps having a thick filament suitable for a terminal pressure of, say, 110 volts, and if the supply voltage is higher than this, to put in series with it either a metallic resistance or another lamp. For the purpose of concentrating a beam of light on to the specimen, a double convex lens is employed.

An arrangement which in practice has been found preferable to the filament lamp is the Nernst lamp projector, which is illustrated in Fig. 1. This lamp, which only consumes 1.2 amperes, may be used on either alternating or direct current, although alternating is preferable. If direct current is used it is advisable that the direction of the current be reversed occasionally, as this ensures longer life to the glower. The Nernst projector consists of two main portions, (*a*) the heater, and (*b*) the glower, which is formed of refractory material and does not allow the current to pass until it has been raised to redness by the heater. There is also a compensating series resistance which is self-contained with the projector and, therefore, no special rheostat is needed since the lamp supplies its own resistance. New glowers are readily adjusted should those in use by any chance become fractured. In connection with this outfit, a bull's-eye condenser is provided, as shown, for concentrating the beam, and the projector and condenser are mounted on separate supports.

The arc lamp plays an important part in metallography, and its size depends very largely on what is required from the outfit. For optical work only, a small hand-operated arc, taking about 5 amperes, is convenient to use, as it can be connected on to an ordinary lighting circuit without damage. The position of the carbons has to be regulated with great nicety, for which each carbon has an independent adjustment in order to secure an uniform light, and when this is done the illumination is brilliant and steady, making it suitable either for visual examination or some forms of photography. The arc lamp may, of course, be used either with direct or alternating current, and where photograph work has to be done an iris diaphragm is often attached to the sleeve of the bull's-eye condenser, or it may be placed on a heavy base between the lamp and the microscope. A blue glass screen is also attached to the diaphragm, and preferably an automatic shutter is attached to this lamp, unless there is a shutter on the camera. The carbons of a small apparatus of this kind should be 8 and 6 millimetres diameter, for the positive and negative respectively. For larger powers, a full-sized arc lamp, taking 14 millimetres diameter carbons for the positive and 11 millimetres for the negative, should be used for direct current, while for alternating current both the upper and lower carbons should be cored, and both of 14 millimetres diameter. The best arrangement of carbons is to place them at an angle of 90 degrees to one another, as in Fig. 2, which shows a hand-feed arc for this purpose. By this arrangement the full illuminating power of the crater is used, the source of light being always in the optical axis, and fluctuation of light in the microscope or in the camera screen is thus avoided. Direct current is, on the whole, preferable for microscopic work, as, since there is only one crater the source of light more nearly approaches the ideal point of light.

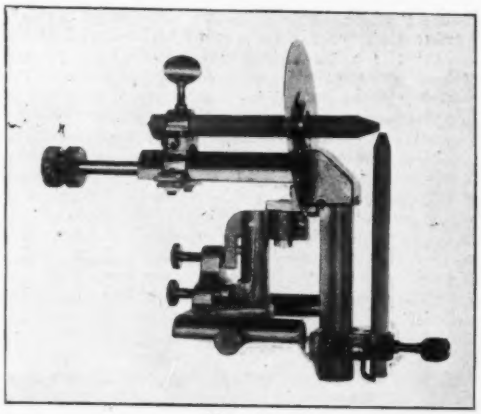


FIG. 2.

The direct arc is also quieter in operation than the alternating arc. For photographic work, the exposures with a full-sized beam range from a fraction of a second on low magnifications to about 15 seconds on magnifications of about 1,000 diameters. Where it is considered advisable to adopt automatic feed the type shown in Fig. 3 is available for direct current. It keeps the arc centred and of constant length and can be utilised as a hand-feed lamp when desired. Passing into the lamp box are two long rods on which the lamp itself can slide, and these allow of the lamp being withdrawn from the case for inserting new carbons without removing it from the slide. In order to gather the largest number of rays from the arc, a triple condenser system of one meniscus-convex and two plano-convex condensing lenses are placed in front of the arc with a water tank or cooling cells placed between the combinations.

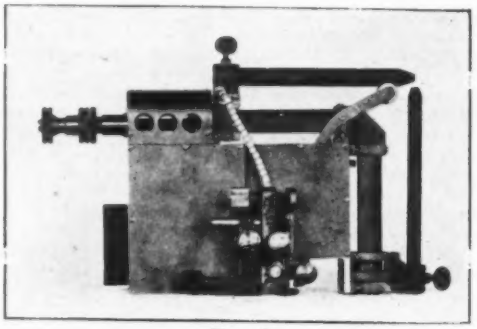


FIG. 3.

The two lenses nearest the lamp project a parallel beam if light, which is converged by the front lens into a vertical illuminator mounted above the objective of the microscope. An iris diaphragm is provided for the purpose of centring and regulating the beam of light. The lens nearest the microscope has a considerable range of movement along the optical bench on which the whole arrangement is mounted, in order that the distance at which the spot of light entering the vertical illuminator is focussed, may be changed as required. For transparent micro-slide projection, a projecting microscope with sub-stage and iris diaphragm and projection eyepiece can be attached to this arrangement. Fig. 4 illustrates the assembled parts of a large arc-lamp outfit, comprised of the parts above described and mounted on an optical bench, 15 in. long, provided with a V-shaped surface with a T slot for securing the standards in position. For levelling the bench the two feet on the front are provided with levelling screws.

In the examination of magnetic objects, it has been found that a specimen holder made from special magnetic steel, treated so as to maintain its magnetism permanently, is a very useful adjunct, especially in connection with a mechanical stage, such as is shown in Fig. 5. This stage is provided with longitudinal and lateral motions so as to bring any desired spot on the specimen into the field of the microscope. For non-magnetic specimens a rubber band is used to hold the specimen firmly in the holder, or a thin metal templet and a cover glass may be inserted between it and the specimen, if the correction of the objective requires it. By the use of these specimen holders the tedious operation of producing exactly parallel surfaces, or of mounting the specimen in some plastic material, is done away with, and the stage with clumsy arrangements to provide levelling screws is also avoided. It will be seen in Fig. 5 that in addition to the magnetic holder the mechanical stage is supported upon and held up by an electro-magnetic stage, consisting of two prongs or extensions of electro-magnets mounted upon a levelling screw, these magnets being energised by current from the lighting mains. A switch affords a rapid means of securely clamping the mechanical stage into position at any point. For large specimens the mechanical stage may be done away with altogether, reliance being placed simply on the electro-magnet holder.

The camera may be mounted on a heavy base, a vertical graduated steel-bar support holding the camera vertically, and upon which it can be clamped in any desired position. An improvement is to make the camera inclinable at any angle from the vertical to the horizontal position, and the camera is then connected with the microscope by means of a light-tight double metal cylinder. A convenient size of negative for photomicrography is $3\frac{1}{4}$ in. by $4\frac{1}{4}$ in. and by keeping the microscope on the base of the camera in the proper position to be connected to the bellows of the camera and keeping the camera vertical, it requires only a minute or so to make the necessary connection whenever it is desired to photograph an object. An alternative arrangement is illustrated in Fig. 6, in which a horizontal-vertical attachment is used consisting of a prism especially mounted and fastened rigidly to the end of the camera nearest to the microscope or to the automatic shutter when this is used. It allows the camera to be used in a horizontal position, while the microscope is maintained in the ordinary vertical position.

The microscope is mounted on a small wooden block in order to bring the vertical illuminator on the microscope (which is either a plain glass reflector or a Zeiss prism) directing a horizontal beam of light downward to the proper height to allow the beam from the arc lamp to enter it, while allowing the full use of the long working distance of the stand. The microscope is used in the ordinary way for visual examination, the lamp adjustments being easily reached by the operator from his position at the microscope. The front standard of the camera to

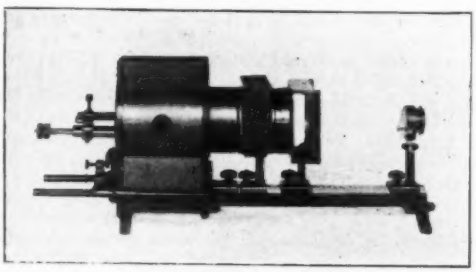


FIG. 4.

which the special prism is attached is moved along the bed bar to a sufficient distance. In order to bring the camera into position for photography the front standard is brought towards the microscope until the collar beneath the prism rests on the microscope, and thus the focus of the microscope is not changed in the least. The bottom of this collar, which is fitted with a felt rim, rests directly upon the eye piece without exerting any pressure, but tightly enough to make a light-tight connection. The image is then focussed upon the camera screen by the fine adjustment and the exposure quickly made.

Other applications of electricity include the driving of machines polishing metal specimens before examination under the microscope, the polishing machine usually being driven by means of a small

motor at about 1,200 revolutions per minute. Where soft materials have to be polished as well as iron and steel specimens it is useful to have a variable-speed motor capable of giving anything from 600 to 1,400 revolutions per minute at the spindle of the polishing head. Alternatively direct-coupling or belt-drive may be used, although a direct-coupling lends itself to the use of a small size of motor and extreme compactness. For cutting the specimens before polishing, either a power hack-saw may be used running at about 40 revolutions per minute, and belt-driven by a small electric motor, feed being applied by gravity, or with refractory metals such as high-speed steel, manganese steel, white or mottled cast iron, or hardened carbon steel, a rotary diamond saw can be used, say 6 in. in diameter. The diamond saw can be mounted direct on one of the polishing machines,

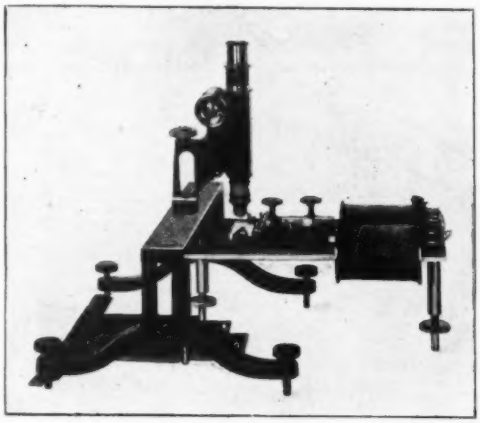


FIG. 5.

or be driven by a similar motor to that used on such machines. For cutting metallographic specimens, emery cutting discs are also sometimes used, these being usually about 12 in. in diameter and $\frac{1}{8}$ in. thick. In order to detect flaws in polished specimens and fractures, a magnifier with micrometer attachment is very often used, consisting of a doublet focussing glass fitted with a reflector, which when

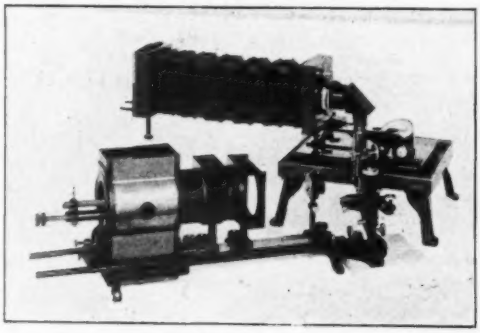


FIG. 6.

used in conjunction with an electric lamp gives a brilliant surface illumination on the specimen. By means of this magnifier and a small steel rule it is also possible to accurately measure to one-tenth of a millimetre the impressions made by the Brenell ball test, etc.

In the metallographic laboratory a small furnace in which high temperatures may be obtained and which at the same time is under perfect control, is a most necessary piece of apparatus. A form which has been most extensively used is the muffle furnace of the type designed by Heraeus. The heating is effected by means of a fine platinum winding around the muffle and also on the back so as to secure great uniformity of temperature and to avoid any possibility of cracking the muffle. The rheostat is built into the furnace itself, and by its means any temperature between 800 deg. and 1,000 deg. Centigrade can be maintained constant with great ease and accuracy. It is not advisable to maintain temperatures of over 1,000 deg. for any length of time, as this tends to shorten the life of the muffle. In order to avoid danger of overheating, electric safety devices are attached to cut out the current should it become excessive.

The Cementation of Iron by Solid Carbon.*

By G. CHARPY and S. BONNEROT.

The conclusion drawn by the authors from their experiments—mainly those carried on with variable gas pressures measured by the MacLeod gauge—are that no cementation of iron is effected by solid carbon at temperatures in the vicinity of 950 deg. in the absence of a gaseous medium, apparently carbon monoxide, which acts as a carrier between the carbon and the iron. It cannot, however, be deduced from this circumstance that there is no diffusion of carbon into the iron, as would appear from the changes observed in the structure of cast iron and steel heated above the critical points. On the one hand, it is difficult to identify the part played in this diffusion by the occluded gases, since, up to the present, no one has ever operated with metal entirely free from gases. On the other hand, it must be pointed out that the contact is not established in the same conditions in comparison with the case of carbon compressed between two fragments of steel, or a particle of graphite or cementite embedded in the midst of a mass of cast iron or steel.

Various observations tend to show that the adhesion between two bodies may vary within very wide limits, according as the contact is more or less perfect; but, even with the application of considerable pressure, the authors have not succeeded in effecting, between carbon and steel, a degree of adhesion comparable to that existing between graphite and ferrite in cast iron. In fact, all through, the degree of adhesion obtained was somewhat weak. On the other hand, the conditions of the experiments which are described by the author did not enable pressure to be maintained at high temperatures, and thus enable the part played by such pressure to be elucidated. For this purpose it would be necessary to employ an apparatus of the kind used for investigating the separation of graphite under pressure—an apparatus, however, which does not permit of the experiments being conducted in a space from which all gases have been evacuated.

Hence, even if it be admitted that solid carbon situated externally with regard to a piece of steel, cannot penetrate the latter without the intervention of a gaseous medium, fresh experiments are necessary to decide whether the diffusion of carbon to the interior of cast iron and steel occurs with or without the intermediary of the occluded gases in the metal.

* Abstracted from "Révue de Metallurgie."

Chilling and Hardening Cast Iron.*

By Thos. D. West.

Occasionally an "inside chill" is produced in a casting, by which is meant that a casting with a grey soft exterior may have the interior, or portions of it, composed of a hard, white or chilled iron. While inside chilling is claimed to be produced by hydraulic pressure, this is not the inside chill which has puzzled foundrymen.

In the following experiments for the mechanical creation of inside chill, the irons used were approximately of the following composition:—Carbon, 2.75 to 3.25; silicon, 1.75 to 2.00; sulphur about 0.06; manganese and phosphorus each about 0.04. In cases where a more chillable metal was desired, small portions of stick or powdered sulphur were dropped on top of the molten metal when in the hand ladle.

In Fig. 1 is illustrated an experiment that created mechanically an inside chill. This gives views of the mould used in casting in open sand test specimens of

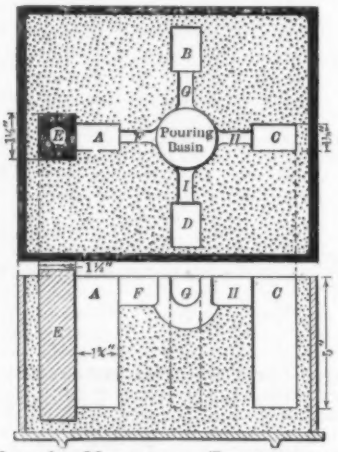


FIG. 1.—MOULD FOR TEST-BARS IN INSIDE CHILL EXPERIMENTS.

size 6¼ in. by 1¾ in. by 1½ in. The bar A was cast against a chiller block as at E, while bars B, C and D were surrounded with rammed sand. The bars having been poured, the gate connections F, G, H and I were broken, and the sand around C and D removed as soon as their solidification would permit. When it was thought C and D would stand the pressure of tongs, they were lifted quickly, and C was doused in water, while D was broken to display the condition of its interior. The immersed bar C having cooled to a dark colour, it was taken from the water and broken, and displayed an inside chill, such as is seen at E', Fig. 4. The bar D showed an interior condition bordering on semi-molten metal. The chilled bar A showed that the chiller E had chilled the surface of A about ½ in. deep, while the bar B had a nice grey fracture. Bars A and B were not removed from their moulds until nearly cold.

The explanation of mechanically creating an inside chill is in the outside body of the casting cooling slowly enough to allow the carbon to take a graphitic form, while the inner body, which is not wholly solidified, is then cooled so rapidly that the carbon is held in the combined form.

The ability to create an inside chill by strictly physical manipulation suggested that it might be practicable to increase the depth of a chill beyond what present chillers can do, with like irons. Especially was this thought practicable for such castings as chilled car-wheels and rolls.

Variable Conditions Affecting Chilling.

In the chilling of cast iron, the following actions take place and conditions exist:—

(*a*) Chillable iron is chilled prior to any formation of graphite. The chilled portion may be made harder by continuing to cool it while the adjoining metal is

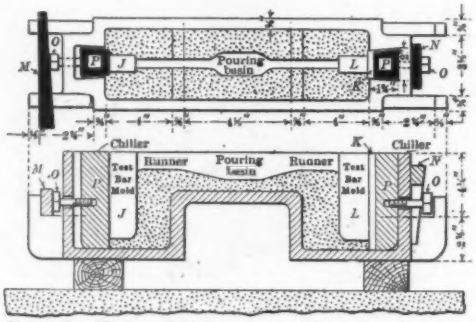


FIG. 2.—TWIN MOULD FOR MAKING CHILLED SPECIMENS.

still in a semi-molten state or very hot; as by this action any backward annealing to soften the chill is more or less retarded.

(*b*) Under like conditions, the lower the silicon and the higher the sulphur and carbon, the deeper the chill.

(*c*) Under like conditions, the chill will be deeper the smaller the area of the cross-section to be chilled.

(*d*) Under like conditions, the less the thickness in the chiller below what can be utilised, the less the chill in the casting.

(*e*) The longer the casting remains in close contact with its chiller while its metal is in a chillable state, the deeper the chill.

(*f*) The more fluid or the hotter the metal used in pouring a chiller mould, all other conditions being the same, the deeper the chill, from ⅛ in. to possibly ⅜ in.; and the greater the chillable nature of the metal, the more pronounced this effect.

(*g*) Not all grades of cast iron are chillable. It requires, as a rule, for iron of average carbon content, less than 2 per cent. of silicon and above 0.06 per cent. of sulphur.

Mould for Comparative Chilling Tests.

In order to make comparative tests, a twin-chiller mould was designed as shown in Fig. 2. By having the two moulds combined so that they could be poured from the same basin, it was possible to make all the conditions alike in both, except the condition which it was desired should vary. The mould was further designed to produce conditions similar to those existing when casting chilled car wheels and rolls. In

* Abstract of Paper presented before the American Society of Mechanical Engineers.

making these latter castings the contraction of the chilled crust and the expansion of the chiller create a space between the exterior body of the casting and the interior face of the chiller.

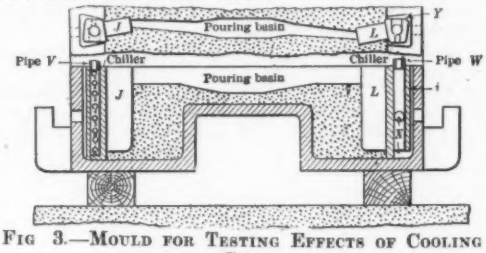


FIG 3.—MOULD FOR TESTING EFFECTS OF COOLING THE CHILLER.

In order to obtain a variable action so far as the chillers P, Fig. 2, were concerned, the braces M were removed and the wedges N driven down. When it was desired to have the space K in both moulds, two persons were employed to work in unison at their respective ends. The wedges N would not be knocked down until the metal filling the mould showed evidence at the top edge of the bars of having solidified sufficiently to produce a self-sustaining crust. A manipulative chiller P was employed, each of these chillers weighing 3 lbs. 14 ozs., and the bars averaging 3 lbs. 4 ozs.

Experiments with Hardening Materials.

In starting to use the twin-chiller mould, the first manipulation was to draw back the chiller P of one mould about ¼ in. from the face of its bar casting as soon as the latter had solidified sufficiently to have a self-supporting crust facing the chiller, while the companion bar was left in close contact with its chiller until of a dark colour (see Fig. 2). In various tests a ¼-in. space K, Fig. 2, was formed by moving back the chiller, and the effect tried of quickly packing different materials into this space upon the backward movement of the chiller. No noticeable effects were produced by the use of these intended hardeners. The thickness of chill of the bars kept in close contact with their chillers exceeded that of the treated bars by from ¼ to ⅜ in. In a further series of tests, both chillers were pulled back at the same moment to create spaces adjacent to both bars, as at K, to discover if any greater depth of chill or hardening was produced by packing one of the spaces quickly with the materials used in the first experiments, while the other space was left open. The series showed the chill in several of the treated bars to be from 1-16 in. to ⅛ in. deeper than in the non-treated bars.

Immersion Experiments.

For this series, open-sand moulds of the plan shown in Fig. 1 were used, and two of the four bars were removed as soon as the crust solidification permitted. One of these bars was immersed and moved around in a pan of mud, which in some tests had salt mixed with it, while the second bar was simultaneously submerged in water. These tests were duplicated by having the pan nearly filled with a high fire-test oil in place of the mud. The tests showed that the mud or oil cooling had little or no effect in chilling, on the average, while the water cooling was radical in its action. A^1, B^1, C^1 and D^1, Fig. 4, give a fair illustration of these tests. A^1 is the chiller-cooled bar; B^1 the all-sand one; C^1 the mud-cooled bar, and D^1 the one placed in water. Bars A^1 and D^1 were both left in their moulds to cool naturally.

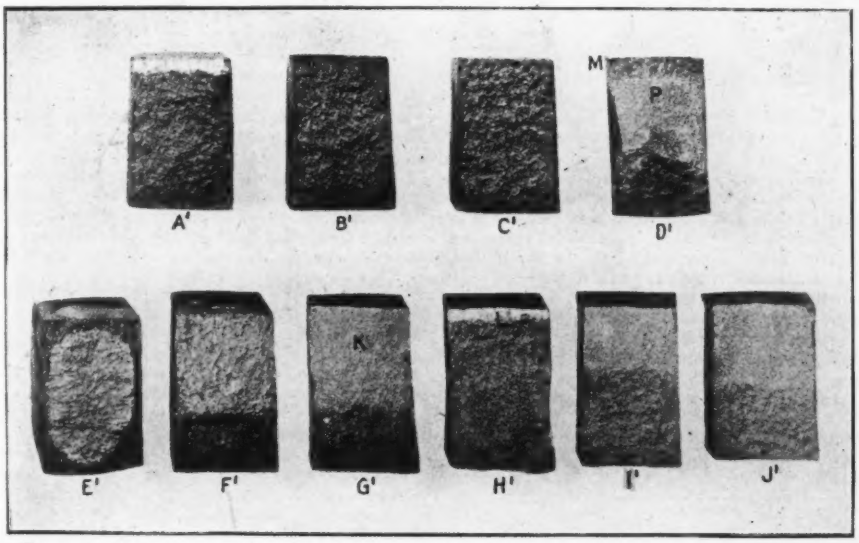


FIG. 4.—TEST-BAR FRACTURES; A^1 TO D^1 ILLUSTRATE IMMERSION EXPERIMENTS; E^1 SHOWS INSIDE CHILL; F^1 SHOWS FRACTURE OF CHILLER-COOLED BAR; G^1 TO J^1 ILLUSTRATE AIR-CHILLING *v.* METAL-CHILLER EXPERIMENTS.

The bar D^1 displayed an inside chill as seen by the white appearance at P, and the grey corners and surface indicated by M. The best example of this effect, which was closely duplicated in several tests, is seen at E^1 in connection with the chiller-cooled companion bar F^1, which latter was cast against the face of the chiller E, Fig. 1, the same as bar A^1 in Fig. 4. The bar F^1 showed that harder grade of iron was used than for A^1.

Hardening by Impingement of Air against Surface.

Special attention was paid in this series of tests to the hardening effect of air applied directly to the hot

chilled face of a bar. For tests of this character it is essential that the depth of chill in the comparative bars be of the same thickness. This condition was obtained by admitting the air to the chilled bar only after it was thought the inner metal had all solidified, so that it could not be held responsible for any variation of depth of chill in the treated bars. Only three specimens of this series were tested by the scleroscope, as given in Table I ; but from filing and grinding tests made as a check on the results it is evident that a chill's hardness can be very materially increased by applying air. Tests of the grey sides of the chilled bars for the second and third tests in Table I. gave 52 and 42 respectively.

TABLE I.—*Scleroscope Tests for Hardness.*

Set Number of Test.	Set 1.	Set 2.	Set 3
Average of air-cooled chilled bars	56	65	61
Average of natural-cooled chilled bars ..	48	58	53
Average of increase in hardness effected ..	8	7	8

Experiments were then conducted with a view to learning whether air saturated with water might be more effective than air alone in creating a chill, or in hardening; and a device was used which made it possible to vary the proportion of air or water as desired. It was demonstrated that so far as the chilling was concerned there was little to be gained by the saturated air, or what was gained could be secured by the use of a greater volume of air alone, so that the water could be dispensed with. As regards the effect of saturated air as a hardening medium, however, among the tests in which saturated air was strongly applied, one gave 70 for the treated bar, and 52 for the non-treated bar, a gain of 34.6 per cent.

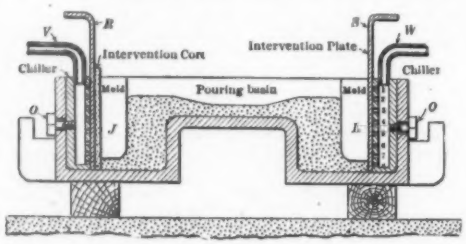


FIG. 6.—INTERVENTION PLATE SYSTEM FOR AIR-COOLING AND CHILLING.

Softening Effect of Annealing Chilled Iron.

Specimens of this series of tests were cast in the twin-chiller mould, arranged as in Fig. 3, without applying any air cooling to either chillers. This gave the same depth of chill in both bars. Several sets were cast and annealed, but only one set was tested by the scleroscope. Other sets showed by filing and grinding that they corresponded closely with those tested by the scleroscope. The annealing was done as follows : The bars were taken out of their mould together and one left in the open air, of about 70 deg. Fah., while the other was laid on the bottom of a hot crucible furnace, the oil fire having been shut off, and left there about twelve hours.

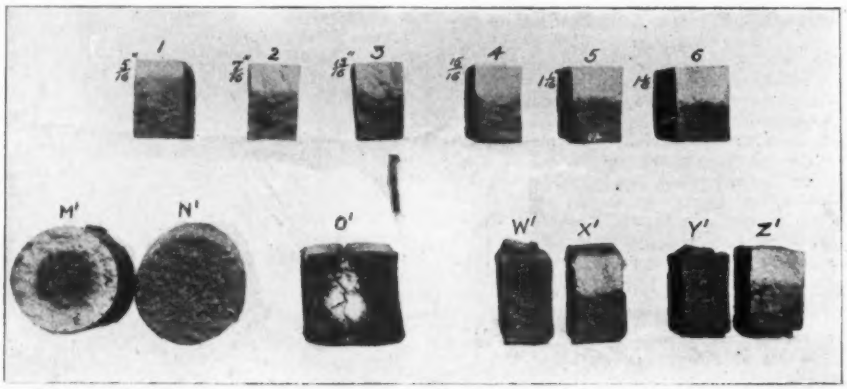


FIG. 5.—TEST-BAR FRACTURES ; 1 TO 6 ILLUSTRATE EFFICIENCY OF CHILLERS OF DIFFERENT THICKNESSES ; M' TO Z' ILLUSTRATE RESULTS WITH SAND-FACED MOULDS AND AIR-COOLED BARS CONTAINING VANADIUM AND TITANIUM.

The chilled side of the unannealed bar when tested showed a figure of hardness of 68 and the grey side 45. The chilled side of the annealed bar showed 47 and the grey side 35.

Relative Efficiency of Warm and Cold Chillers and of Different Thicknesses.

Experiments were then undertaken to determine the efficiency of different metals and of different thicknesses of metal for chillers, and also the relative efficiency of warm and cold chillers.

As regards the latter, the tests showed from 1-16 in. to 3-16 in. greater depth of chill in the bars having the cold chiller than those having the heated ones.

To determine the effect of different thicknesses of chillers, tests were made, and for this series open sand moulds were used. The chillers were respectively ¼ in., ½ in., ¾ in., 1 in., 2 in., and 3 in. thick; and all 2 in. wide by 9 in. deep. The test specimens cast against these chillers were 8 in. by 1⅞ in. by 2½ in. The top row of fracture views, Nos. 1 to 6, Fig. 5, is a fair representation of results obtained. The thickness of chill in the samples shown in Fig. 5 is approximately as marked. A study of these samples demonstrates that the efficiency of chillers in general use is far from being in accord with their thickness. The 3-in. chiller, for example, produced but 3-16 in. more depth of chill than the 1-in. chiller.

These tests also suggest the advisability of makers of chilled rolls, car wheels, etc., trying steel chillers in place of the much heavier cast-iron ones. Steel chillers need be made only of the thickness required for efficiency in cooling and would still be strong enough to resist the contraction and expansion strains to which chillers are subjected. There is a liability or difficulty being encountered in using steel chillers on account of the steel warping much more than

cast-iron, through repeated heating. By using ribs or giving a special form to steel chillers this objection may be greatly reduced, if not wholly overcome.

Efficiency of Different Metals for Chillers.

Tests were made to decide whether any difference existed in the efficiency of chillers of grey, white or all-chilled cast-iron or of steel or wrought iron; but while slight differences in the thicknesses of the chills resulting from chillers of the different materials seemed to indicate that one or another of the materials produced the deepest chill, there was so little practical difference in the results, taking an average of all the tests, that none of the chillers could be rated as being decidedly better than the others.

The chief information sought in another series of tests was whether, when a casting contracts away from a chiller, the depth of chill is increased by cooling the chiller, and at what point the cooling ceases to have this effect. In the use of chillers for car wheels, rolls, etc., the contraction of the casting and expansion of the chiller leave a space between the two, and these tests were therefore well adapted to demonstrate whether internally or externally cooled chillers used for this class of castings would produce a deeper chill than those not cooled. Half a dozen tests were made without finding any practical difference in the depth or character of the chill produced by an air-cooled chiller bar and that produced by the chiller which was not cooled.

Chilling by Sand-Faced Moulds.

To ascertain whether a chill could be created by air under pressure when prevented by a sand coating from getting directly at the hot surface of a casting, tests were made by the method illustrated in Figs. 6, 7, and 8. In using the mould shown in Fig. 6 an intervention core was employed, as shown on the left, about ¼ in. thick, and well wired so that the head pressure of the molten metal could not break it. The first test of this series demonstrated the porosity of a sand mould's surface. Although this was a very hard core, the 50-lb. air pressure used carried the air through it and would have blown all the metal out of its mould had not the valve been closed. Further tests with these cores under different air pressures showed that the cores prevented any chilling action. The difficulty with this core method lies in the fact that air under sufficient pressure to penetrate the core and carry off heat in time to create an internal chill will pass clear through the molten metal instead of forming a crust and chilling it. As regards the method depicted in Figs. 7 and 8, a study of the sand-coated pipe P^1 will show that any pressure up to 200 lbs. and over can be employed without causing the air to impinge against the molten metal, while at the same time it can be more effective than the core itself in conveying heat to its outer surface and then to the atmosphere. The sand coating used on this pipe was but ⅛ in. thick and thoroughly dried. To carry off the gases from the sand the iron pipe was closely perforated with 3-32-in. holes as at Q^1. Air under 60-lb. pressure entered at R^1 to the chamber S^1 and passed up through the holes T^1 surrounding the pipe P^1. The air in the chamber U^1 was free to absorb heat from the pipe P^1 and to carry it rapidly to the atmosphere. About 10 seconds after pouring the mould, the air was admitted and kept in action until all the metal was thought to have solidified. A fair illustration of results is seen at M^1, Fig. 5. An all-sand moulded, non-treated companion bar, cast from the same ladle, is seen at N^1.

There is little doubt but that the pipe P^1 acted as a chilling agent without the use of air, as there was only ⅛ in. thickness of sand between it and the face of the casting. In fact, a test made without the air showed that the pipe aided the chilling, since it gave a density to the crust of the casting. Again it is to be kept in mind that as the diameter of the casting was only 2¼ in., its contraction would not be sufficient to create a visible space between its outer body and the face of the mould, as is generally created in casting chilled rolls, car wheels, etc.

In the all-sand mould, Fig. 8, which was also dried, the air passed up through holes T^1, which were ¼ in. in diameter and about the same distance apart, all around the circumference, as seen by the plan view. The air escaped freely around the top at V^1. The holes T^1 had only about 3-16 in. thickness of sand between their inner exterior and the face of the mould. Castings produced by this method showed a dense exterior of crust of from ⅛ in. to ⅜ in. thick and in some instances were slightly mottled. Only in one case was there any display of chill, and this was of an irregular character, ⅛ in. to ¼ in. thick, created inside of a grey crust about ⅛ in. thick. In reality this was an example of inside chill, one of the factors sought in these experiments being to learn if by such methods it could be produced at will and if it was controllable.

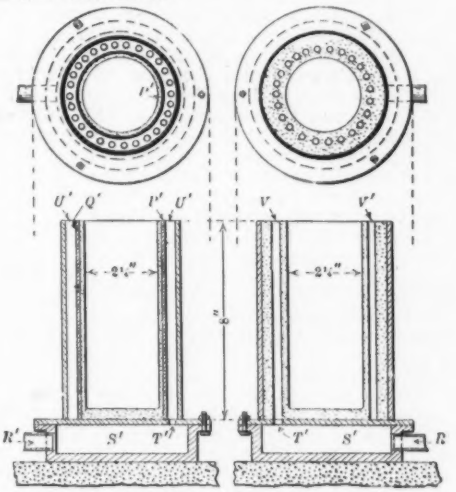


FIG. 7.—PIPE SAND-COATED AIR-CHILLING MOULD. FIG. 8.—ALL-SAND AIR-COOLED MOULD.

It is evident that in constructing chillers to be cooled by air, etc., sufficient consideration has not been given to the question of transmission of heat. Such spaces existing as at K, Fig. 2, greatly retard the absorption by the chiller of heat from the castings. This emphasises the utility of filling such a space as K with a heat-absorbing medium that can be moved swiftly from an inlet to an outlet to carry off heat and allow cooling, hardening or chilling.

Heat Conductivity of Sand, Iron and Air.

Tests were made for the purpose of ascertaining the heat conductivity of moulds, composed of a sand body, and again of iron, as chillers, instead of having a heat-absorbing medium impinge directly against the hot surface of the casting with exits for the rapid escape of the medium to the atmosphere. The sand was shown to be the least effective as a conductor of heat, while the iron was not very much better when compared to the conductive power of air applied directly to the surface of the hot bar,

It was seen that from the moment the air impinged upon the surface of the hot bars its temperature rose, and in less than 30 seconds after the mould was poured reached 200 deg. Fahr.

Experiments were further made with air cooled by passing through a pipe coil surrounded by a mixture of two parts of cracked ice and one part of salt. The temperature was reduced thereby from 85 deg. to 45 deg., but no greater chilling effect was observed in the six tests conducted on this plan than in the first series with the air as it came from the tanks. This is as would be expected, since the reduction of the temperature of the air by 40 deg. is so small in amount compared with the temperature of 2,000 deg. which it may be assumed the surface of the molten bar would have.

Tests were also conducted with air at higher pressures. At 50 lbs. pressure a chill was created for a depth of 1½ in. in the air-cooled bar, whereas the naturally cooled bar had a depth of chill of only 1-16 in., as seen respectively at K and L in the bars G^1 and H^1, Fig. 4. The grey body of both of these bars displayed a fine texture bordering on a mottled state. This test removed every possible doubt of the efficiency of air-cooling for chilling.

Later, tests of the same character were conducted by having titanium and vanadium in the metal. Two sets of these samples are shown at W^1 and X^1 and again at Y^1 and Z^1, Fig. 5. Here as in G^1 and H^1, Fig. 4, the air was by far the most effective in chilling. The air-treated bars showed about ⅞ in. depth of chill whereas their companions had but about ⅛ in. chill. In line with these tests a series was made to determine whether air chilling was more effective than chilling by means of a solid chiller held in close contact with its bars. Samples of bars contrasting these two methods are seen at I^1 and J^1, Fig. 4, the air-cooled bar at J^1 having ¾ in. chill, while the other at I^1, produced by the close-contact chiller bar, has ⅛ in. chill.

Chilling of iron must be accomplished prior to the formation of graphite, and with like irons the quicker and more penetrating the cooling action, the deeper and harder the chill. The direct application of a heat-absorbing medium to the surface of a hot casting as soon as contact with its chiller is broken or a crust is formed, provides means at a critical moment which can not but be of material benefit in increasing the utility of cooling, densifying, or chilling and hardening of chillable and other grades of cast iron.

Chilling After the Metal Solidifies.

It has always been thought that in chilling iron, the action ceased the moment the molten metal solidified. The writer's late experiments show that such is not the case; but that with chillable iron there exists a period of 20 to 30 seconds or more after the formation of a crust before any graphite is separated out, when iron can be chilled. This was demonstrated as follows:—A casting was poured in open sand and freed of its sand, this being done about 2½ minutes after the casting was poured. The space was then immediately filled with cold water, kept running until the casting was cold. Upon breaking the specimen it was found, if a high chilling iron, to be a homogeneous body of all chilled or white iron with a discoloured or reddish centre. But if, instead of surrounding the specimen with water at the expiration of 2½ minutes, there were allowed to lapse 3 to 3½ minutes before doing so, the crust exhibited graphitic formation, while the interior body was found to exist in a mottled or all-white state, showing the inside chill to have been created.

These tests indicate the existence of two laws positive in their action, as follows:—First, cooling or chilling is effective in creating or continuing a chill in a casting for a period of 20 to 30 seconds after its molten metal has solidified. This permits a continuation of chilling with castings like rolls and car wheels which break contact with their chillers immediately after the formation of their chilled crust. Second, the formation of graphite having once taken place in the crust or body of a hot casting, no sudden cooling can restore the carbon to its original combined form, and only by remelting can it be so transformed as to have a chilled or white-iron structure.

The variable conditions that must be considered and controlled to an exactness in order to create a perfect inside chill are as follows:—(*a*) Temperature of the pouring metal; (*b*) "temper" of the sand; (*c*) atmospheric conditions; (*d*) nature of the iron; (*e*) size of the specimen; (*f*) temperature of the water; (*g*) whether the specimen remains stationary in its mould to be cooled or is removed or moved about in a body of water.

When it is stated that, for an example, with the size of specimen seen in Fig. 1, there are only some 5 to 10 seconds during 1 minute when the perfect inside chill can be created, all students of this problem will realise that at present it is a hit-and-miss process. The writer is of the opinion, that when one can obtain a medium chilling iron in place of the extremes, such will be best for creating an internal chill.

Crucible Steel Furnaces.

The increased life of furnaces used for melting crucible steel under the careful supervision which is now being given to this class of work is again illustrated by the record of a 24-pot furnace in operation at the works of the Colonial Steel Company, Monaca, Pennsylvania. This furnace was in continuous operation from January 10, 1910, until March 20, 1912, a period of 26 months and 10 days, during all of which time the gas was on and the fire kept in the furnace. Steel was melted every day, with the exception of Sundays, 52 Saturdays, and eight days in the month of July, 1911, making in this period 3,513 heats. The total weight of steel melted was 9,274,320 lbs., of which 924,000 lbs. was high-speed steel, the remainder consisting of carbon tool steel and special alloy steels, such as chrome nickel, chrome tungsten and 30 per cent. nickel steel. The total cost for repairs was about £4.

Tempering Aluminium Bronze.

Writing in "Comptes Rendua," on aluminium bronzes, Messrs. A. Portevin and G. Arnou state that aluminium bronzes containing 89.90 per cent. copper consist of a eutectoid in a more or less fine state of division, according to the rate of cooling, and an excess of the copper-rich α constituent. Heating for a sufficient time above the transformation temperature, followed by quenching, results in the disappearance of the α constituent and the structure becomes wholly martensitic, resembling that of hardened steels. Experiments have been made on the effect of tempering on the structure and properties of two industrial alloys containing 89.84 and 88.80 per cent. Cu, 9.95 and 10.02 per cent. Al, and 0.11 and 1.11 per cent. of Mn respectively. Brinell and Shore hardness tests made on quenched specimens subsequently tempered for 10 minutes at temperatures between 400 deg. C. and 700 deg. C. in a molten salt bath showed that up to 400 deg. C. the hardness was increased. This increase was accompanied by a diminished elongation in a tensile test and an increased fragility under shock. Above 500 deg. C. the hardness diminished to below its original value, the elongation increased, and the fragility decreased. Similar phenomena occur in hardened steels and bronzes, all of which exhibit martensitic structures.

The Making of a Guide Blade Chamber Pattern for a Turbine Pump.

By C. A. Otto.

Figs. 1 and 2 represent a guide blade chamber, the former being a sectional elevation and the latter a plan of piece B.

The pattern for piece A, in Fig. 1, is very simple, and need only be considered here to show that the casting must fit very closely the casting of piece B; this latter piece, however, requires much more consideration, and certainly a good deal more work on the part of both patternmaker and moulder.

Probably the first method to suggest itself in making the pattern for piece B would be to make

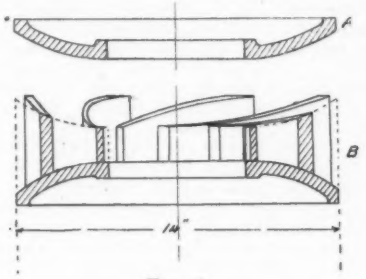


FIG. 1.

it similar to the required casting, making the necessary allowance for contraction; such a method would necessitate a fair amount of skill on the part of the workman, for the ribs are thin and have a quick curve, and owing to the depth of these ribs and the necessity of having a good clean lift in the mould, they would need to be tapered.

The next method which would receive careful attention would be the formation of the ribs by

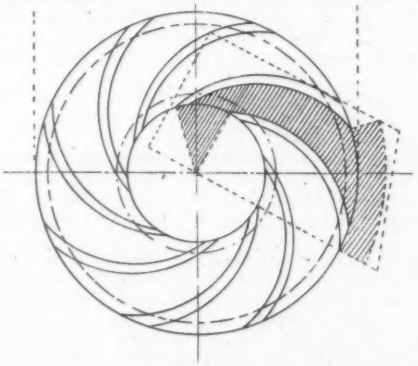


FIG. 2.

means of cores, and taking into consideration that the former method would make a frail pattern to withstand the process of ramming in the foundry, and make the chances of a clean withdrawal from the sand very small, this method would be preferable, because, although the moulding may cost a little more, the pattern would be stronger and cheaper, and a cleaner skinned casting would be the result.

A suitable way of making the block pattern which would be necessary, if the patternmaker decided to use the latter method, is shown by sketches, Figs. 3 and 4, the former being an outside and sectional elevation, and the latter an outside and sectional plan. The outside is increased in diameter to form a continuous print, and the rib side is made flat and level with the points of the ribs.

The construction of the block is very simple, and would not require much work on the part of the patternmaker. The instructions for the work are as follows:—

First, true up a chuck firmly attached to a face plate, taking care to make the chuck a little larger in diameter than the outside of the block, and to this screw two pieces of wood cut semi-circular

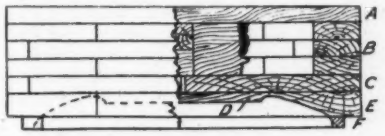


FIG. 3.

(marked A on Fig. 3); true up sufficient to take segments marked B; inside these segments and flush with outside of the last row insert two stays half-lapped at right angles to each other (as shown in Fig. 4) to strengthen the pattern to resist rapping. Next attach other two semi-circular pieces C and true up the face; to this screw a piece of wood and turn it up to a diameter equal to facing D plus the diameter of the fillet; unscrew this and attach segments for E, turning the inside to receive the piece D again; nail and glue segments for the facing marked F and turn the job as shown in Fig. 3, allowing a little taper for drawing purposes, the flat end being the bottom in the mould. Insert a rapping

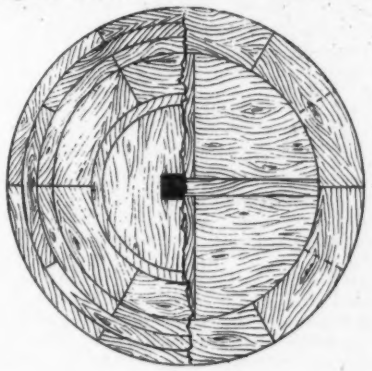


FIG. 4.

and lifting plate in the top, just flush with the surface, and with the lifting screw just over the centre of facing D.

Reverting to Fig. 2, a plan of the core is shown having the amount on for filling the outside print, and showing the method for coring out the central hole. The sides to which the adjacent cores fit are made to radiate from the centre. The method for making the core-box for such a core is shown in

Figs. 5 and 6, the former being a plan looking on the bottom of the box, and the latter an isometric view showing the portion cut out to form the thickness of metal on the top.

A simple box is first made having an inside shape similar to that shown in Fig. 2, and a depth equal to that of the outside print. Afterwards the inside is made up with four pieces of wood screwed from

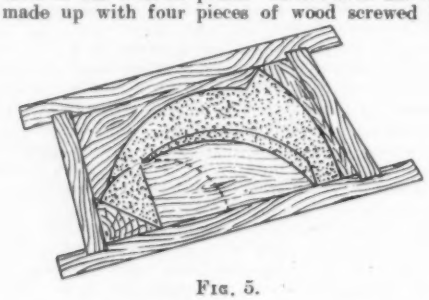


FIG. 5.

the outside of the box to their respective sides, the rib being added as a separate piece, and made the full depth of the box. It is then necessary to cut the top of the box to the required shape so that the thickness of metal will be formed when the cores are inserted in the mould.

The most satisfactory method of making the desired shape is by means of a board having a profiled edge equal to the shape to be cut out and shown in Fig. 6. The procedure is as follows:—Cut down the portion

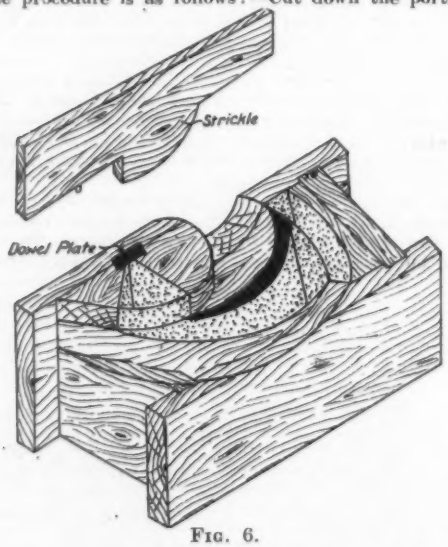


FIG. 6.

about the centre of the core which forms the central hole and insert a dowel plate; attach a dowel to the correct position on the strickle, and cut the shape of the top of the box, using the strickle as a guide. This strickle would also be used with advantage by the coremaker. The loose portion forming the rib now requires to be taken out, and the bottom edge cut similar to the top edge, this is best accomplished by gauging a centre line around the rib and making a number of perpendiculars on each side. By using the intersections of these perpendiculars with the centre line as centres, a shape similar to the top may be marked on the bottom. The correct shape of the rib may then be cut and returned to the box, completing a strong and serviceable job.

A Coke Question.

Before the Lancashire Branch of the British Foundrymen's Association, on May 4, Mr. Harrison raised for discussion the question of which was the better coke to use for cupola work—heavy or light? Mr. Buchanan had maintained that heavy coke was the better, and his test was to immerse it in water. If it sunk it was to be considered a good coke. Mr. Hailstone took the opposite view, and contended that light coke was the best to work with. The point could only be settled by practical experience.

MR. CORDINGLEY had found that the heavier the coke the greater the heat; in other words, if they had weight in coke they would get more heat.

MR. SIMKISS believed in light cokes, which he had been using for many years. During the recent coal strike they had to accept and use what they could get, and he experienced with heavy cokes more trouble than he had ever had before. They had, in fact, to use considerably more for their purpose. He would rather charge with a light coke than with a dense, heavy coke.

A MEMBER had found by experience that they could not get the same results from light as they did from heavy coke.

MR. HARRISON agreed that if they judged by volume, they could not get the same amount of heat from a light coke as they could out of a heavy coke. In a light coke they burned away more than in a heavy one. Mr. Hailstone's argument was that not so much was wasted in drawing away. He did not say with Mr. Cordingley that the heavier the coke the greater the heat.

MR. CORDINGLEY said there was something in very heavy coke that cooled the heat, but if it was a good brand of coke, the heavier it was the better.

The CHAIRMAN asked whether it was not generally understood that by-product coke was heavier than good foundry coke?

MR. HARRISON observed that the by-product coke they were using to-day was the best they had ever used.

The CHAIRMAN said chemical analysis had little to do with it; the physical formation had a greater influence on the efficiency of the coke. An examination under the microscope would tell them more than an analysis.

MR. HARRISON remarked that it was no good using coke that had a high percentage of ash; what they needed was a really good coke.

The CHAIRMAN had seen soft coke which was very heavy, and hard coke which was very light. Some hard coke which looked well and would ring well was very light. They could not, in fact, tell by mere weight.

MR. HARRISON reminded the meeting that the question he had raised did not concern the hardness or the softness of the coke; but, which was the best, light or heavy coke?

MR. CORDINGLEY desired to know if any member had noticed that by using different classes of coke the grain of the iron was altered.

The CHAIRMAN: That is, what effect has the coke upon the iron?

MR. HARRISON replied that that was a very big subject. It was quite possible to close the grain of an iron but not to open it. He did not think they could make iron softer by using a particular sort of coke.

The CHAIRMAN: Has any member ever found that any sort of coke will open the grain of his iron?

MR. SIMKISS said the grain would be according to the amount of heat present.

The Proper Handling of Crucibles.

The following particulars are taken from a useful booklet issued by the Jonathan Bartley Crucible Company, Trenton, New Jersey, U.S.A :—

Each manufacturer of graphite crucibles has his own formulas and methods. These are not obtained by any great scientific research based on hypothesis, but are the result of actual experimenting and work on the foundry floor. The margin of safety in computing formulas for different classes of work is very small, so that a slight deviation from a proper formula will prove disastrous. Different work requires a different formula; for example, one designed for and which works well on steel will not give good results on brass; one suitable for nickel is not suitable for steel, etc.

While analysis of raw material is essential to produce a uniform crucible, an analysis of the crucible itself shows practically nothing beyond the limit of simple comparison. A chemist can make an accurate analysis of a crucible; he can tell you exactly how much moisture it contains, how much carbon, silica (free and combined), alumina, iron oxide, alkalies, etc., but he cannot separate the free from the combined, and a hundred different concoctions can be made that will prove the same analysis, but be widely different in the physical construction. A laboratory test amounts to nothing; the crucial test on which the crucible must stand or fall is made on the foundry floor.

In making a successful graphite crucible there are four important points to be considered :—(1) The raw materials in proper proportions must be graded carefully by repeated analysis. (2) Proper mixing and preparation. (3) Perfect moulds and machinery that will form the crucibles under a pressure sufficient to make the walls homogeneous. (4) Proper and sufficient burning.

The first of these is obtained only by buying the highest grades of graphite. As regards the second requirement, nothing short of practical experience will produce satisfactory results. On the matter of forming a crucible in the moulds, care should be exercised to have the material brought up from one solid mass without any separation. To accomplish this necessitates specially designed machinery with forms carrying perfect "feed" lines, so that no disruption occurs. The crucible makers' burning is only for one purpose—that of calcining the clay. It, however, is a delicate operation and requires a long experience to accomplish perfectly.

Crucibles are formed or "turned up" in plaster of Paris or wooden moulds, much the same as ordinary pottery ware. At the time of making they contain about 20 per cent. moisture. When in the drying process this moisture has been expelled, the crucible has undergone a physical change; in other words, it is 5 per cent. smaller than it was at the time it was made. It requires from four to six weeks to dispel this moisture sufficiently to go through the burning process. As already stated, the object of the crucible-maker's burning is simply to calcine the clay matter. The physical properties of the clay are changed—it is clay no longer. Yet, while it has lost its plasticity, it will, on becoming cool, absorb very readily what is known as hygroscopic moisture, or, in other words, the moisture that is in the air. Just how much it will absorb depends entirely on the amount of moisture there is in the place where it stands. For example : In one instance a crucible was taken from the kiln, tested, and found to contain less than one-quarter of one per cent. moisture, placed in a room where the temperature registered 90 deg. F., and five hours later it contained two and seven-tenths per cent. moisture. It was then submitted to atmospheric conditions, and five hours later it contained four and one-half per cent. moisture. From this illustration can be seen the value of proper annealing.

Annealing.

To anneal properly there can be no "cast-iron" rule. Every shop or foundry has a "condition that confronts" it, and where in one instance, "A" could use his core oven consistently to properly anneal his crucibles, it would be ruinous for "B" to adopt this method. "A" might have a shop where few cores were used and the oven could be almost entirely devoted to the annealing of crucibles; "B" might have an oven where cores were used extensively and the cores might be large. To place crucibles in an oven with a load of wet cores would be something in the order of putting a cat in the same cage with a canary bird. The crucibles would quickly absorb the moisture, and while it is true that a sufficient time and heat would eliminate danger to both, the practice is generally considered a dangerous one.

Another method of annealing which is quite popular among small foundries is to place a crucible on top of a furnace. This practice in most cases is all right provided the melter uses discretion. Crucibles, as a rule, when they arrive at the foundry contain from four to five per cent. moisture. If they are placed at once on top of a very hot furnace there is a chance of an immediate "scalp," and should they show no external damage, a too sudden annealing might cause an internal fracture which would in a few runs develop a leak, or what are commonly known as "pin holes."

The best device for annealing crucibles is a furnace built expressly for the purpose, using the wasted heat from the furnace on its way to the stack. These can be built so that the heat can be regulated and the temperature brought gradually from zero to or above 250 deg. F. The average size crucible should remain in this temperature at least 48 hours before going in the furnace. Larger sizes require more time.

Tongs.

That the tongs play a very important part in the life of a crucible is shown by the fact that in the tilting furnace, where the lifting in and out is eliminated, the crucible will run more than double the number of heats. Foundrymen as a rule are too careless in considering the importance of manipulating this end of their work.

When the crucible is under its melting heat it is plastic and readily adjusts itself to any irregular shape to fit the tongs. After a pour is made and the crucible cools off it will retain this irregular shape. In the second operation unless the tongs are placed in the exact position an unequal strain will occur, and this repeated time after time weakens the crucible and naturally shortens its life.

Dangerous Gases.

In actual use there is nothing more detrimental to a graphite crucible than the gases that arise from impure fuel. While their influence is indicated on the interior of the crucible, their deadly effect permeates the entire wall and it frequently happens that while the crucible has leaked or cracked in its early life, the walls retain their original thickness, but

when broken exhibit a dead, dull colour, showing that the life blood has been extracted by the pernicious influence of the gases.

Both coal and coke which contain sulphur to any great extent will produce this result, particularly if used in a wet or damp condition. Imperfect combustion with oil or gas will also act the same or even to a greater extent, due to the fact that in the coal or coke fire the crucible is almost completely submerged by the fuel and thus protected from the extreme oxidising condition, thereby getting the bad effect more at the top of the crucible, whereas in the oil or gas furnace an imperfect combustion affects the entire surface.

These gases are always produced at low temperatures—usually in a coal or coke fire immediately after a fresh charge of fuel, and in the oil or gas furnace at a slight manipulation of the air or fuel valves. It is noticeable that the crucible used in melting steel is never affected by these gases, and this is explained by the fact that they are plunged into a heat sufficiently high to eliminate all gases, and, while this terrific heat, together with the fluxing action of the metal at this heat, tends to make the life of the crucible short, it will be noticed that the wall of the crucible, however thin, retains its original appearance and nature.

Great care should therefore be given to the fuel, seeing first, that it is pure as possible; second, that it is perfectly dry; and third, that it is charged properly at the right time.

Soaking.

The life of a graphite crucible is oft times greatly reduced by what is called in foundry parlance "soaking." While this practice is more general among small founders, it is observed to quite an extent in some of the larger plants. At the beginning of the day's work the furnaces are fired, the charge made and the crucible placed. The moulders begin their work, and 9.30 a.m. finds the metal sufficiently melted for a "pour," but the moulder is not ready, and it often occurs that two, three or four hours pass before the pour is made. All this time the crucible is simply living its life on wasted energy. Under a condition of this kind the ordinary life of a crucible can be divided by three.

British Foundrymen's Association: Lancashire Branch.

Election of Officers.

The final meeting of the Session 1911-12 of the Lancashire Branch of the British Foundrymen's Association was held on Saturday, May 4. In the unavoidable absence of Mr. Penlington, the Branch President, Mr. W. H. Sherburn presided, the first business being the election of the officers for the next session.

Mr. H. Sherburn (hon. sec.) in his report of the work done during the session, stated that they might congratulate themselves on the results attained. Three visits to works had been arranged by the Council, but owing to the recent coal strike only one, to Messrs. Hornsby's Engine Works at Reddish, had taken place, and that had proved a pronounced success. The other two had been postponed, but the Council still had the matter before them. The annual dinner on January 13 was also very successful. The financial position was more satisfactory than in some former years, there being a small balance in hand. They had 30 members, 83 associate members and 22 associates, which showed an increase, as compared with the numbers 12 months ago, of 10 members, 12 associate members and 11 associates. Those figures did not include the members who were transferred to the recently formed Halifax Branch. The increased membership was due to the exertions of individual members. The balance sheet for the year showed income from the parent body £16 10s. 4½d., including £4 10s. 4½d. brought forward from the previous session. The expenditure amounted to £11 7s. 7d., leaving £5 2s. 9½d. to be carried forward. The sum of £29 14s. had been received on account of members' subscriptions, and had been duly placed to the credit of the Branch. In presenting the report Mr. Sherburn remarked, "It is estimated that there are within the area of this Branch between 200 and 300 foundries. Recent developments in every industry using castings are demanding a higher standard of castings at a lower cost than ever obtained before. The knowledge of those responsible for the production of castings must therefore be greater in order to meet the higher standard. There is, unfortunately, much prejudice, misunderstanding and lack of interest among foundry and pattern-shop managers and foremen. We also find many autocrats among them who imagine that their results are never attained by any other foundries, and who have long revolved only in their particular orbit, and have consequently magnified it, until they are almost persuaded that they are the hub of the foundry universe and that wisdom will die with them. I have also come in contact with moulders who would join the Association, but cannot afford to risk the displeasure of a narrow-minded or jealous foreman, who is really afraid to have competent men about him."

The report was adopted.

Mr. Penlington was unanimously re-elected President of the Branch for the coming year

The Chairman said the Council, after considering the matter, had come to the conclusion that it was unnecessary to have four Vice-presidents as hitherto, and suggested that the number should be reduced to two.

The suggestion was approved by the meeting, and Messrs. J. Simkiss, of Manchester, and T. W. Markland, of Bolton, were unanimously appointed.

The Chairman remarked that the present hon. secretary, Mr. H. Sherburn, had occupied the office for four years, and feeling the time had come when a change would be to the interest of the Branch, he asked to be relieved. The Committee had agreed to his request, but of course the matter was in the hands of the meeting. If the resignation was accepted the Council recommended the appointment of Mr. A. Harrison, who had very kindly consented to take the office if they wished him to do so.

On the motion of Mr. H. Sherburn, seconded by Mr. Simkiss, Mr. Harrison was elected.

The following were appointed to constitute the Council: Messrs. R. W. Kenyon, D. Cordingley, F. Critchly, W. McVie, H. Sherburn and T. Hilton.

Mr. Whittam, in proposing a hearty vote of thanks to the officers for their services during the past year, remarked that they were very greatly indebted to those gentlemen for all they had done to promote the interests and well-being of the Branch. (Hear, hear.)

Mr. Cordingley seconded the motion. It must, he said, have been a labour of love to Mr. Sherburn, to have fulfilled the duties of the secretaryship in the manner in which he had done. (Hear, hear.)

The motion was carried by acclamation and suitably acknowledged.

The death is announced of Mr. R. Pratt, manager for Cochrane & Company, Limited (Cochrane Grove Branch), Ormesby Ironworks, Cargo Fleet, Middlesbrough.

The Influence of Carbon on the Corrodibility of Iron.*

By C. Chappell, B.Met. (Hons.), Sheffield.

During the past few years the subject of the corrosion of iron and steel has been receiving a well-merited and rapidly increasing attention. Despite this fact, however, it is often difficult to obtain reliable information as to the specific influence exerted upon the corrosion of these metals by varying proportions of alloying elements. Especially is this the case with regard to the influence of increasing percentages of carbon on the corrodibility of iron. In view, therefore, of the prime importance of carbon in the metallurgy of steel, investigations have been carried out to ascertain the nature and extent of this influence.

Two main elements of uncertainty enter more or less into practically all the experimental results that are available in connection with this question—the lack of chemical purity in the steels employed, and the negligence of precautions to ensure that the steels shall be in a uniform condition of treatment before testing.

Special attention has been paid to these two features throughout the present Paper, which will therefore constitute a basis from which the influence of other elements upon the corrodibility of steel may subsequently be individually and accurately determined.

General Scheme of Investigation.

A series of practically pure iron-carbon steels has been prepared. Suitable bars of each steel have been subjected to typical heat treatments, and their relative corrodibilities and other properties have been investigated in each of these various states of heat treatment. By these means, not only has the influence exerted on these properties by variations in carbon percentage been determined, but also the influence of variations in the chemical and physical condition in which the carbon exists in these alloys, within the range of commercial treatments.

Microscopic investigations into the *modus operandi* of the corrosion of iron-carbon steels have also been made, and have been productive of much interesting and important evidence, despite the considerable difficulty of examining corroded surfaces at high magnifications.

Production and Composition of the Steels.

The steels were all manufactured by the coke crucible process in the Metallurgical Department of the University of Sheffield. Six ingots were made, ranging from 36 lbs. to 40 lbs. in weight. The carbon contents ranged from 0.10 per cent. to 0.96 per cent. The materials employed throughout the series were Swedish bar iron and charcoal. This method has previously proved itself by far the most satisfactory one for the production of iron-carbon steel of a high degree of purity. "Killing" was effected by aluminium in every case, and all the steels gave sound ingots.

The chemical analysis of the steels is given in Table I., together with the distinguishing number employed throughout the research for each steel.

It will be observed that in no case do the total impurities exceed 0.28 per cent.

TABLE I.—*Analysis of Steels.*

Steel No.	Carbon.	Silicon.	Manganese.	Sulphur.	Phosphorus.	Aluminium.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	0.10	0.019	0.091	0.030	0.011	0.02
2	0.24	0.037	0.072	0.028	0.015	—
3	0.30	0.030	0.094	0.021	0.012	—
4	0.55	0.053	0.100	0.020	0.017	0.03
5	0.81	0.048	0 168	0.028	0.016	—
6	0 96	0.018	0.133	0.027	0.014	0.02

Treatment of Steels.

Each ingot was rolled down so as to give about 4 ft. of ¾-in. round bar, and the remainder taken down to ⅝-in. diameter. The treatments employed may be briefly described as follows:—(1) Rolled, (2) normalised at 900 deg. C., cooled in air, (3) annealed at 950 deg. C. for 20 hours, very slowly cooled in furnace, (4) quenched from 800 deg. C. in water, (5) quenched from 800 deg. C., tempered at 400 deg. C., (6) quenched from 800 deg. C., tempered at 500 deg. C.

Corrosion Tests.

Method of Experiment.—Test bars, 4½ in. long by ⅝ in. diameter, were prepared from each steel in all states of treatment. Each bar was polished in the lathe to an uniformly high degree of polish with fine emery-paper, and suspended in 700 cubic centimetres of filtered sea water.

After 91 days' immersion, the bars were taken out, well washed, cleaned with chamois leather until all adherent deposits were removed, dried thoroughly, and weighed again. The bars were then re-immersed in the same jars and sea water as before, for a further period of 75 days, cleaned thoroughly again, and re-weighed.

Summary of Results.

(1) *Influence of Carbon on Corrodibility.*—(*a*) In rolled, normalised, and annealed steels the corrodibility rises with carbon content to a maximum at saturation point (0.89 per cent. carbon), and falls with further increase of carbon beyond this point. (*b*) In quenched and tempered steels a continuous rise in corrodibility occurs, with increase of carbon within the range investigated (up to 0.96 per cent. carbon), no maximum corrodibility at saturation point being found in these steels.

(2) *Influence of Treatment on Corrodibility.*—Quenching increases the corrodibility to a maximum; annealing tends to reduce it to a minimum; whilst normalising gives intermediate values. The influence of tempering varies with the tempering temperature.

(3) *Factors Determining Corrodibility.*—The electromotive forces between the pearlite and ferrite, and between the components of the pearlite itself, are the principal factors determining the corrodibility of unsaturated pearlitic steels above 0.4 per cent. carbon. In mild structural steels this galvanic action, due to differences of potential between the constituents, is accompanied by galvanic action between the ferrite crystals themselves. These differences of electro-potential between the ferrite crystals are the result of differences in their orientation. The

* Abstract of Paper read before the Iron and Steel Institute May, 1912.

state of division of the pearlite, and the presence of internal stresses in the steel, may also exert a considerable modifying influence on the foregoing factors.

(4) The influence of time on the rate of corrosion varies with different steels. In a low-carbon steel it is shown to be practically directly proportional to the length of immersion.

(5) The influence of corrosion on the resistance offered by a low-carbon steel to alternating stress is not appreciable within a period of five months' immersion.

(6) Three per cent. of tungsten produces practically no change in the corrodibility of carbon steels.

(7) Decarbonisation increases the resistance to corrosion.

SKETCH MAP SHOWING LOCATION OF HAN-YEH-PING COMPANY'S OPERATIONS.

(8) The two oxides, FeO and Fe_3O_4 (mill scale) both exert a microscopical pitting effect on steel when in contact with it in sea water.

(9) *Solubility.*—The solubilities of all the steels were determined in several acids, and also their electro-potentials after forty-eight hours' immersion. Further investigation into the factors involved in the solution of steel in acids is intended before any detailed communication on the influence of carbon and treatment on solubility is made. It may be stated, however, that the absence of correlation between the corrodibilities of the steels and their solubilities in 1 per cent. sulphuric acid solution is very marked. The so-called acceleration tests, in which the relative solubilities of steels in 1 per cent. sulphuric acid solution are taken as indicative of their relative corrodibilities in neutral solutions, are entirely misleading and unreliable.

A Chinese Iron Company.*

The Han-Yeh-Ping Iron and Coal Company's operations are conducted at three chief plants: (1) Han-yang iron and steel works, (2) Ta-yeh iron mines and limestone quarry, (8) Ping-hsiang coal mine and coking plant. The location of these plants is shown on the accompanying sketch map.

The Han-yang iron works were established in 1891 by the late Grand Counsellor Chang Chih-Tung, the iron-mining company in 1897, and the coal-mining and coking plant in 1898. Since then the company has recorded progress every year. Besides these three plants mentioned, this company owns also some manganese and small iron-ore mines in Hunan Province.

The Han-yang Iron and Steel Works are situated on the northern bank of the Yang-tse River, being separated from Hankow by the Han River, and from Wu-chang, the capital of Hupei Province, by the Yang-tse River. The ironworks consist of three modern blast furnaces and produce about 500 tons of pig-iron every day, or 180,000 tons per year. The height of the two old furnaces is about 70 ft., and the external diameter 20 ft. About two-thirds of the pig-iron produced goes to the steel plant for making rails, angles, beams, plates, sheets, and all sorts of railway supplies. A small portion is used in the foundry, and some is sold to the native works of the surrounding cities. The rest of the pig-iron is exported to Japan and the United States. Table I. states the composition of the pig-iron and finished steel made by this company :—

TABLE I.—*Analyses of Han-yang Products.*

—	Foundry pig-iron.	Basic pig-iron.	Finished steel.
	Per cent.	Per cent.	Per cent.
C	3.80	3.900	0.400
Si	2.50	0.650	0.085
Mn	1.00	1.100	0.080
S	0.01	0.045	0.055
P	0.02	0.250	0.028

The steel plant consists of six Siemens-Martin open-hearth furnaces, one mixing furnace, a cogging mill, joist and angle mill, rail mill, plate mill, and some other plants, capable of rolling 1,000 tons of finished product per day. At present the output of steel is about 300 tons per day.

* From the "School of Mines Quarterly."

Association Technique de Fonderie.

At a general meeting of the Association Technique de Fonderie, held at Paris recently, the following officers were elected :—

President.—M. Barthe, managing-director of the Société Metallurgique du Périgord.

Vice-Presidents.—Messrs. Bonnivert (foundries of the John Cockerill Company, Seraing, Belgium), Carlos-Petrement (director of the Aciéries Talleres de Deusto, Bilbao, Spain), Vanzetti (Aciéries Milanaises, Milan), Chappée (Mans), A. Deries (director of the Société Horme et Buire), Albert Deville (Charleville), Charles Haller (director of the Société Métallurgique d'Aubrives et Villerupt), Tissot (Aciéries de Paris-Outreau).

Treasurer.—M. Ronceray, of the Société des Etablissements Bonvillain et Ronceray, Paris.

Secretary.—M. Camille Didier, manager of the journal, "La Fonderie Moderne."

Members of Council.—Messrs. Brasseur (Luxemburg), Lamberton (Merzweiller, Alsace-Lorraine), Bermond (Société Bermond et Ce., Dôle), J. de Broisgrollier (Usines de Mazières, Bourges), Damour (Fonderies de Bayard, Haute-Marne), E. Decollogne (Pont-Audemer, Eure), A. Dellis-Riquaire (Ferrière-la-Grande, Nord), Eissen-Piat (Les Fils de A. Piat, Paris), Albert Lebel (Amiens), Masson ("Mécanique Moderne," Nancy), J. Poinsat (Etablissements Durenne), M. Montupet (Nogent-sur-Oise), Ramas (Société Française Métallurgique, Gorcy), Révillon (Paris), Thomas (Soissons), Thuau (Rennes).

A Large Light-Castings Foundry.

On June 8 last a party of members of the London Branch of the British Foundrymen's Association paid a visit of inspection to the works of the Davis Gas Stove Company, Limited, Diamond Foundry, Luton. Considerable interest was attached to the visit, as the works in question include what is probably the largest light-castings foundry under one roof in England. The work turned out consists mainly of gas stoves of a considerable variety of design, but the foundry also produces a large range of rain-water goods and builders' castings.

On first entering the works the party were conducted through the pattern-shop, where tin and wood patterns are prepared from drawings. Practically all the work in the foundry is moulded from cast-iron patterns, which are produced from the original tin patterns. The castings for patterns are worked up almost entirely by file, chisel, etc., and some very intricate work is produced in this way. The white-metal patterns which are frequently associated with this trade were conspicuous by their absence, except in the case of one or two small parts. A notable feature which attracted the attention of the visitors was the extent to which plate moulding was employed. It was difficult to find a spare corner on any plate, the allotment of patterns being made with a view to economy of space and rapid production.

Curiously enough, in the foundry, which was next visited, although the moulding was practically all repetition work, there was scarcely a moulding machine to be seen. The foundry itself is a building about 440 ft. long by 300 ft. wide. The number of moulders employed is about 300, and an explanation of the absence of moulding machines was seen in the rapidity with which the moulds were being turned out by hand; in fact, we were given to understand that moulding-machine makers would not guarantee a similar output from machines. The whole of the moulding is conducted on a piece-work basis, which the firm consider to be conducive to rapid work. The sand used on the moulding floor is a rather sharp, local yellow sand, and a high proportion of used sand is employed.

At one end of the foundry building are situated two drop-bottom cupolas of 5 ft. 6 in. diameter, which have each a capacity of 10 to 12 tons per hour, the average melt per day from one cupola being about 70 tons. The system of melting is somewhat distinct from the usual grey-iron foundry practice, the tapping being continuous from the arrival of the first metal to the close of the day's melt. The cupola is kept well charged to the charging door and the tapping hole is not botted up after the first tapping. Slagging, too, is practically continuous, largely by reason of the fact that the crucible of the cupola is only some 18 in. deep and consequently there is no room to allow slag accumulation.

The ladles for conveying the metal to the pouring floor follow each other rapidly, and to catch the stream of continuously-flowing metal from the cupola a small tray-formed ladle is swung into position during the changing of the receiving ladles. The metal is then run to the moulding floor on overhead runways covering the whole moulding area. These runways are employed for all the conveying operations of the moulding floor, though the main tracks are also laid with narrow-gauge rails.

As regards the cupola practice, a hard Durham coke is used, and the ratio of coke consumed is 1¼ cwts. per ton of iron. For the work which this foundry turns out, as is usual, a highly phosphoric pig is employed, the brands at present in use being principally Kettering and Wellingborough. The foundry's own scrap and purchased light scrap with this pig make up the charge. As flux for the cupola is employed a chalk, which on analysis shows about 70 per cent. calcium, and the amount charged is 40 lbs. per ton of metal. For the cupola blast both a fan and a positive-pressure blower are installed, but the fan has long been out of commission in favour of the blower. An electric motor of 65 h.p., 500 volts, and 750 r.p.m., operates the blower.

In the core-room, which was in turn visited, the same sand as employed in the foundry is used for core-making, with a German core-compound as binder. The core-making practice is worthy of particular attention. The core-makers are mostly girls working on the day-wage basis. It will, of course, be understood that repetition cores in large quantities are turned out, and as these cores are made of a mixture which until baked is extremely tender and weak, the usual practice of turning the core out of the box before baking cannot be employed. Accordingly the bottom half of the core-box is large duplicated, and in one of these the bottom half is made; the top part is then placed on and the top box removed, leaving the complete core in the bottom half. The core is then taken in this part to the drying stove, and a fresh bottom part with the original top used for the next core. This, of course, means heavy outlay in bottom core-boxes, but is necessary in the system. The cores when baked are extremely hard and stand considerable rough handling.

Passing from the core-room the visitors inspected in turn the grinding and dressing shop, equipped with carborundum and other grinding wheels; and the enamelling and finishing shops. In the warehouse, where the stoves are packed, a great variety of finished articles was to be seen. In one corner is the stove-testing shop, a darkened room where the flames of the burners are tested before the stoves are finally fitted. The packing room and despatching department is served by a branch of the railway running directly into the works, so that the goods may be loaded straight to the trucks for consigning. The whole works are laid out with a view to rapid production and economy of operation, and the output runs to something like 40 or 45 tons of castings per day, which, in view of the light nature of same, is very considerable. The works are lighted throughout by incandescent gas.

At the conclusion of the visit the members were met by Mr. Harold Davis, one of the principals of the Company, who expressed his pleasure at seeing them there. He remarked that the works had been occupied for the last five years, and during that time had about doubled in size. He had no doubt the practice they had seen was very different to that which obtained in most of their foundries.

Mr. J. E. Ellis, Vice-President of the Branch, expressed the thanks of the Association and the members to the firm for their kindness in permitting the visit, which then concluded.

We have received from Messrs. Alldays & Onions Pneumatic Engineering Company, Limited, Great Western Works, Birmingham, a copy of their new catalogue of water boshes and tue irons, wrought and cast water-tue irons, smith's hearth backs, swage blocks, mandrils, etc.

The Manufacture of Angle Plates.

By Francis W. Shaw.

Some twenty-eight years ago, a small firm of engineers, now defunct, put on the market a small line of angle-plates. Quite unexpectedly the demand at once became fairly large, showing that there existed quite a large number of users who preferred to buy rather than make their own. For many years the firm in question had the entire supply in their hands, and even to-day the firms manufacturing angle-plates could probably be counted on the fingers of one hand, although practically every firm of engineers' supply merchants holds stocks and catalogues them. With competition, prices have naturally found a fair level, making the question of methods of manufacture an important consideration.

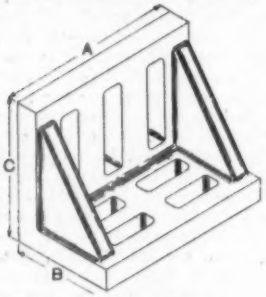


FIG. 1.—ANGLE PLATE WITH WEBS.

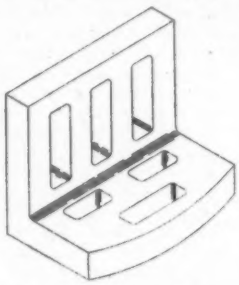


FIG. 2.—ANGLE PLATE WITHOUT WEBS.

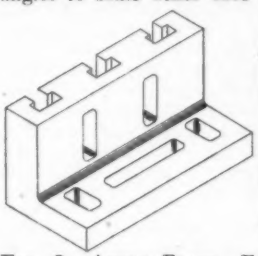


FIG. 3.—ANGLE PLATE WITH TEE SLOTS.

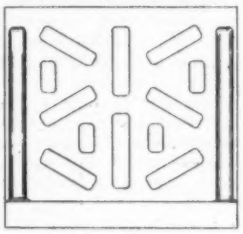


FIG. 4.—SPECIAL ARRANGEMENT OF SLOTS.

Angle-plates are of three general types as shown in Figs. 1, 2, and 3. Each of these types are made in several different ways: with webs, as shown in Fig. 1; without webs as Fig. 2; planed on outside faces and edges; when without webs, planed all over; with slots; without slots; with specially arranged slots. To cover all these different arrangements, and at the same time avoid a burdensome multiplication of patterns, needed a fair amount of consideration, the result of which will be made clear later.

Of angle-plates Figs. 1 and 2, with their variations, the number of different sizes listed is 36, ranging from 3 in. by 1½ in. by 1½ in. to 24 in. by 12 in. by 12 in. in dimensions A, B, and C respectively.. Fig. 3 type is made in 8 different sizes, ranging from 6 in. by 3 in. by 2½ in. to 30 in. by 24 in. by 18 in. in the same dimensions. In all, then, are 44 different sizes, and when it is considered that standard types are made each in four different varieties—making 176 in all—the necessity for careful methods of manufacture will be self-evident.

A considerable part of the sale consists of castings unmachined, many firms, particularly the smaller ones, being desirous of machining the angle-plates in their own works. In addition, many "specials" are asked for, consisting of sizes not listed, this entailing again special methods of manufacture to minimise pattern-making and moulding. Fig. 4 shows a variation in location of slots, the taste in slots being a very variable one.

There is scarcely a machine tool in which the angle-plate does not play at times an important role. On the lathe type Fig. 2 is used for bolting on work in which a face or hole has to be turned or bored at right angles to some other face or part. Sometimes two are used to act as a vise. On the milling machine, slotting machine, planing machine, boring mill, boring machine—in fact on practically every machine tool—they are used for chucking work where faces, etc., have to be machined mutually at right angles. The angle-plate type Fig. 3 is of particular service on planing machines, probably more being used for this work than any other.

Making the Patterns.

Fig. 5 shows some of the means used to save multiplication of patterns. All standard patterns are made of cast iron, the side plates and webs being loose—in separate pieces. The two side plates A and B are planed all over to the shape shown, and the web D is made from a wood pattern and filed up smooth.

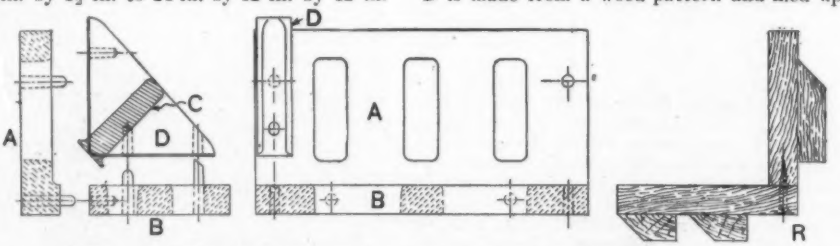


FIG. 5.—CONSTRUCTION OF STANDARD AND SPECIAL PATTERNS.

Note the section C of the web showing a slight taper, and the corner of the fillet blunted to prevent accidental damage. The parts are freely dowelled together with taper dowels. The slots are machined from the solid, and are slightly tapered with corners rounded to facilitate drawing from the mould. Special patterns are made of pine, and the slots cored out with dry sand cores. The prints are arranged to

be fast to the pattern (see R, Fig. 5), and are therefore made so as to draw from the sand in the manner shown later. No attempt is made to produce an elaborate job, and they are not even painted or varnished. No fillets are fitted, but the moulder is instructed to use care in moulding off the sand. As a rule suitable webs for the wood patterns are to be found amongst the standard metal ones. When specials are needed without slots or with slots in one face only, the pattern is arranged to mould one face (the slotted face when slots are to be furnished) up, the mould being inverted for casting so that this face is at the bottom. The joint is at this face. Extra machining is allowed on the narrow edges, always cast up, to take the dirt, and in the larger sizes dirt risers are provided. Multiplication of core-boxes for the slots is avoided, as far as possible, by a standardisation of widths and lengths of slots, the combined thickness of plate and length of print being made to coincide with the depth of the core-box. This system of pattern making has been brought to such a degree of perfection, that only in exceptional cases is more than half an hour needed to prepare a pattern for a special. The price of specials is only a little in excess of standards, the price as a rule being that of the nearest larger size standard, and nett list instead of 10 per cent. discount (to the user).

Moulding Standard Angle-Plates.

To describe methods in general it is proposed to consider type Fig. 1 angle-plate.

The first point to be considered in developing this method is the position of the pattern in the mould. In order to save core-making, the only available method will be found to be that shown in the illustrations, *i.e.*, corner down. Moulded in any other way, it is almost impossible to arrange the work so that the cores will be left in. But this method has several other incidental advantages. First, the outer faces are cast down, ensuring cleaner surfaces; second, the sand lifted in the cope is of a stiff form and lifts easily; and third, the gating is of such a character as to avoid the impingement of the stream of metal on cores, and dirt is readily flushed away.

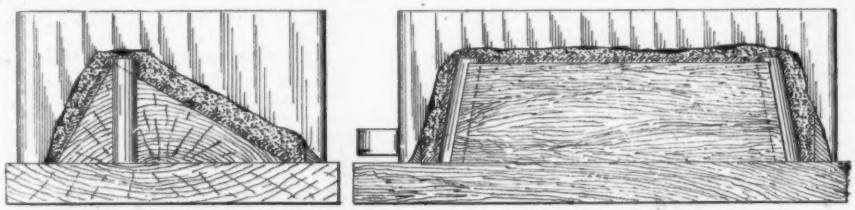


FIG. 6.—FIRST OPERATION: RAM-UP DRAG ON SPECIAL JOINTING-BOARD.

Fig. 6 shows the first operation—ramming up the drag or bottom part on a specially prepared jointing board. At this moment the pattern is not in position. The angular part of the jointing board is made longer than the pattern, so as to form as it were prints for the greensand core in the cope or top part. At each end of this part is cut a groove into which cylindrical sticks are fitted to form prints for the runner and riser. The breadth of the angular faces coincide with the breadth of the outer faces of standard patterns, so that when the drag is removed, turned over and

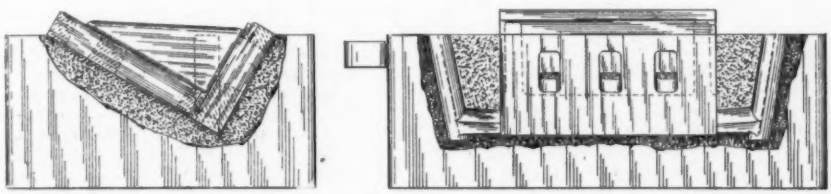


FIG. 7.—SECOND OPERATION: LOCATE PATTERN AND GATE-FORMER IN DRAG.

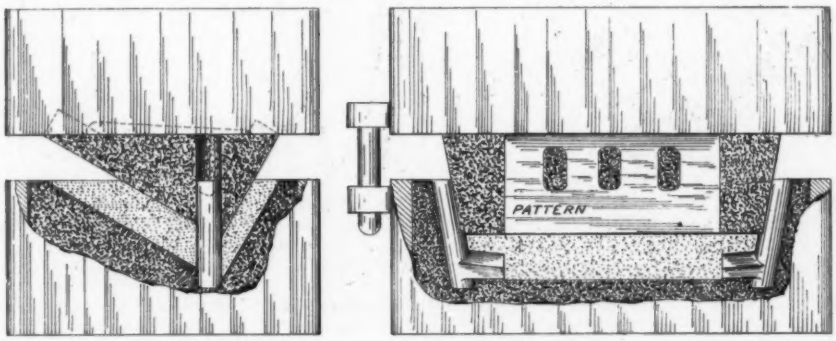
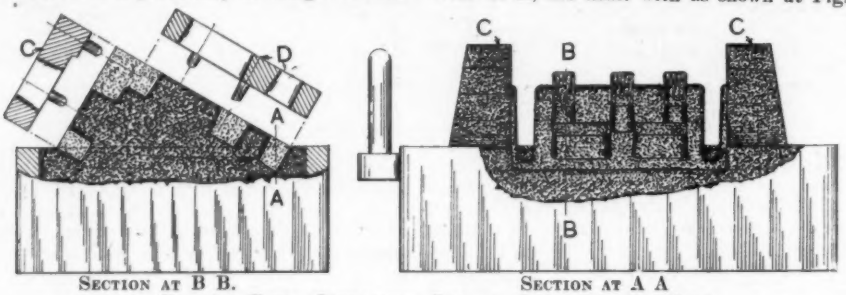


FIG. 8.—THIRD OPERATION: RAM-UP COPE. FOURTH OPERATION: REMOVE COPE WITH PATTERN IN POSITION.

pattern inserted, the latter occupies the position shown in Fig. 7, a view of the second operation.

The second operation entails the insertion of the pattern and gate and runner formers, the latter being located in the depressions left by the cylindrical prints shown in Fig. 6. These gate and runner formers are made of cast-iron, and are carefullly smoothed up.

Fig. 8 shows the third and fourth operations. The cope has been rammed up, and is now being lifted from the drag, drawing with it the whole of the pattern, and leaving in the drag for subsequent withdrawal the gate and runner formers. The whole of the pattern being surrounded by sand and the slots also filled, there is no necessity to secure the pattern to the cope. On account of the abundant taper in every direction, there is practically no danger of sand



Section at B B. Section at A A

Fig. 9.—Fifth Operation: Remove Pattern from Cope.

remaining behind. All the sand joints are made with "wet" dry sand plastered on. Ordinary dry sand does not readily adhere to angular faces such as these. The "wet" dry sand is, of course, used previous to ramming up the cope.

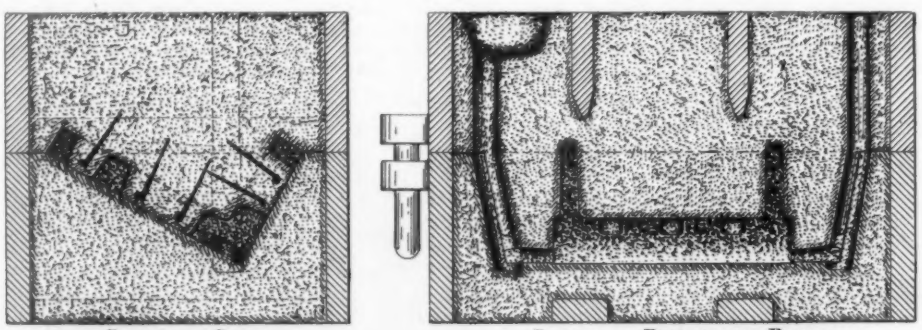
Fig. 9 shows the cope removed and turned over. In the section at AA the sideplates and ribs have been removed. The section at BB shows how the sides are withdrawn, leaving the green sand cores for the slots standing. There is little danger of disrupting the cores, as the pattern plates are guided by their lowermost edges until they leave the cores.

swept along the bottom angle up the riser, whose duty is to act as a dirt expeller rather than as a feeder.

Fig. 11 shows how the same jointing board is made use of for the curved-edge type of angle-plate (Fig. 2). It will be noted that the ends of the curve project into the drag. The little sand which projects under the curved edge after ramming up the drag must, of course, be removed, and the joint made by hand. This entails, however, very little extra labour, which can, indeed, in the case of the chief running sizes be obviated by fitting in strips of wood specially formed in the gaps beneath the curved edge.

Moulding Special Angle-Plates.

Special sizes made from wood patterns as Fig. 5, view at R, are dealt with as shown at Fig. 12. The purpose of the angular-shaped prints will be seen on a reference to Fig. 5. The cores at the left-hand side (dry sand) are bevelled off by the moulder as shown. The angular gaps at A are filled up after withdrawing the pattern. To ensure the cores being fixed at right angles to the faces a template D, is furnished, shown in position at D_2 in dotted lines. The depth of the slots in the template is rather less than the thickness of the plates, so as to ensure a little clearance at the top of the cores, avoiding a crush. Before this method was adopted much trouble was occasioned in this way, and cores were



Section at Slots. Section at Runner and Riser.

Fig. 10.—Sixth Operation: Finish Mould and Replace Cope Ready for Casting.

As a safeguard against this the cores are stayed by springs or cut nails in the manner indicated in Fig. 10, which shows the completion of the mould. In the operation of ramming up the cope, the down runner gate and heads are formed by special patterns which are connected by round metal pins to the tops of the lower runner and gate formers. These are not shown.

Not infrequently after closing up a mould, particles of dirt remain in the lower parts of moulds. By the mould construction shown, all such particles are

frequently out of square so much that when trimmed up the slots were inordinately wide.

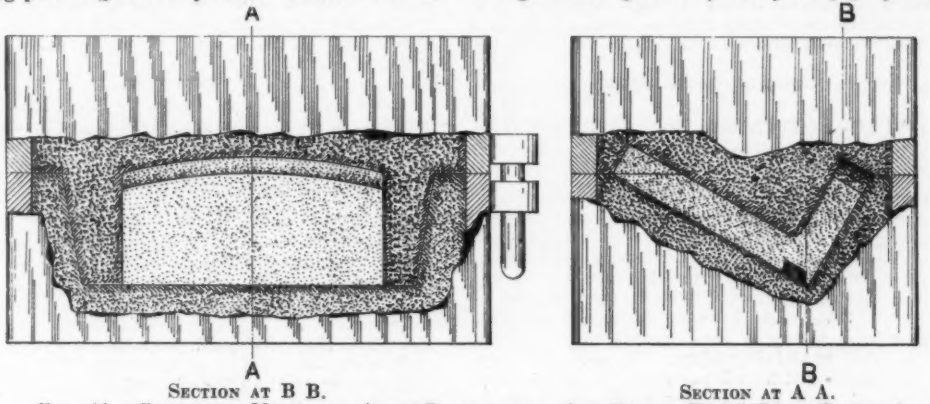
Fig. 13 shows how angle-plates narrower than standard are dealt with, using the nearest standard jointing-board. The sand at C in the cope projects below the joint. Where several angle-plates of the same size are needed to supply an order, this space is made up in the jointing-board by an angular strip to save jointing. Variations from standard lengths are dealt with by cutting the gates by hand if longer

than would be permitted by using the standard gate and runner formers; if shorter than standard the gate and runner formers may be used, and the remaining part of gate cut by hand. There is a limit, of course, to the additional length of angle-plate which can be made on the standard jointing-board, particularly if it have webs. This limit is the limit of weakness of the projecting sand at C, Fig. 9. To some extent this weakness can be obviated by the means shown at Fig. 14. Ordinary gaggers might be used, but the method shown is far more practicable, and comparatively cheap and simple. Wire, varying from 3-16 to ¾ in. in diameter, is bent to the shape shown. To avoid a possible crush from the top, the wire is sunk into grooves chipped into the cross bars of the cope, as shown. In the largest sizes this method of strengthening the downward hanging parts of the cope sand is necessary every time.

This wire method of supporting sand is well worth general adoption. The writer has personally given it a good testing for very nearly every purpose. The wire is readily bent to the exact shape required, hence can be arranged to fit extremely close to the patterns and be got into small space. Bent in the manner shown, it affords sufficient strength to resist all ordinary forces due to turning over the mould and the weight of the sand itself.

Wires, or gaggers, and sprigs (as used at Fig. 10) should be dipped in stiff clay-wash before being inserted; otherwise, if extending too close to the pattern, the sand may drop off into the mould at some inopportune moment.

The methods above advocated have proved so successful as to make the description of more than local



Section at B B. Section at A A.

Fig. 11.—Completed Mould of Angle-Plate with One Curved Edge (Slots Omitted).

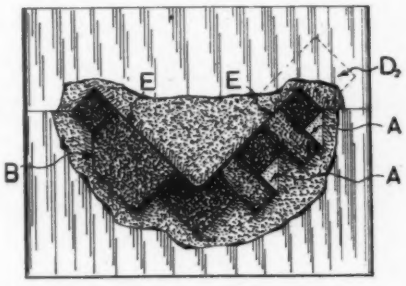


Fig. 12.—Moulding Special Angle-Plates.

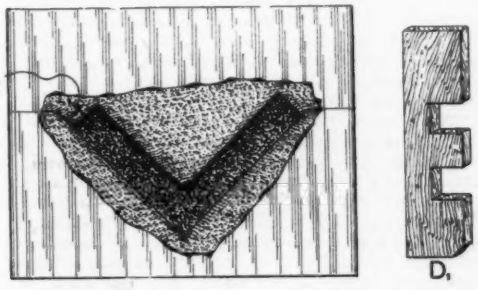


Fig. 13.—Angle-Plate Narrower than Standard.

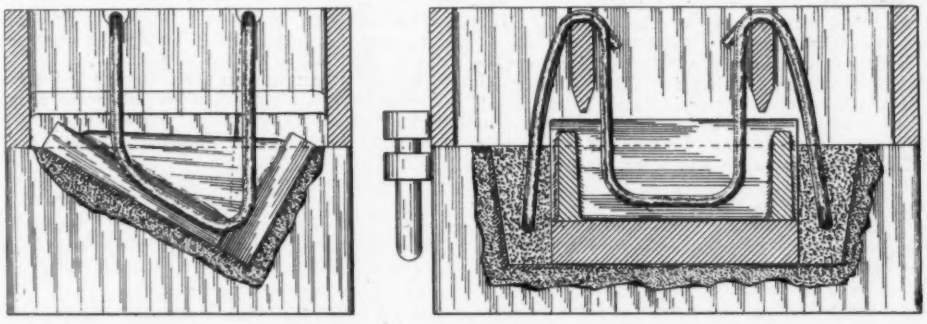


Fig. 14.—Method of Supporting Sand Below Joint of Cope in Large Sizes.

interest, as it is applicable not only to the articles cited, but to many other similar articles. The saving arising from the adoption of specialised methods in the foundry is too seldom realised. Oft-times the provision of some simple tackle—as the jointing-board described—or the careful development of a method, would result in untold saving in labour cost.

Ferro-Tungsten v. Tungsten Powder.

The use of ferro-tungsten in the manufacture of tungsten and high-speed steels offers many advantages over the more generally known tungsten powder. The Société Anonyme Electrometallurgique, Procédés Paul Girod, Ugine (Savoie) manufacture the following different qualities of ferro-tungsten :—Quality "0" containing about 60 to 65 per cent. tungsten and about 3 to 4 per cent. of carbon; quality "1" containing about 60 to 70 per cent. tungsten and about 2 to 3 per cent. of carbon (these two qualities may be used for crucible-making for tungsten steels high in tungsten, if the iron is low in carbon); quality "2" containing 75 to 80 per cent. tungsten and 1 to 2 per cent. of carbon (this is in use by manufacturers of high-speed tool steels); quality "3," containing 80 to 85 per cent. tungsten and maximum 0.75 per cent. to 1 per cent. of carbon, average 0.5 per cent. C. (this quality is specially manufactured for the purpose of replacing tungsten powder, which has already been abandoned by many of the latest special-steel works of France, Austria, Germany, Sweden, Russia, America, etc.).

The Company supply an alloy melted in the electric furnace at a very high temperature. In this the iron and the tungsten are intimately combined, which greatly facilitates the integral absorption of the tungsten by the fused steel. In the ferro-tungsten there are practically no impurities, 0.03 per cent. phosphorus and sulphur being the maximum. Manganese and silicon are only contained in insignificant quantities, and the maximum carbon is 0.75 per cent., generally 0.5 per cent. It is possible to obtain an alloy containing less than 0.5 per cent. carbon, but practice has shown that a good high-speed steel must contain approximately 0.3 to 0.5 per cent. of carbon. The Company claim and, indeed, guarantee that, from the mechanical standpoint the use of their 85 per cent. tungsten alloy gives superior steels to those manufactured with tungsten powder. Further, they claim that steel users may obtain, in many cases, the same quality of steel as that produced with tungsten powder by the use of their 80 per cent. tungsten alloy.

The ferro-tungsten is a product melted at a very high temperature, and being in pieces quickly becomes fused and completely assimilated by the steel. With the use of tungsten powder, however, the situation differs. The powder is refractory; it is a chemical product, more or less pure, and still containing a fair quantity of tungstic acid. This constitutes a first loss, as the acid does not mix thoroughly with the molten mass. Another drawback is the high temperature which must be reached in order to fuse all the tungsten powder added to the steel.

Finally, the Company claim that the composition of their ferro-tungsten is very regular, so that between the single pieces of a charge there is practically no difference in tungsten contents. This is an important feature, for steel manufacturers highly prize the regular and homogeneous qualities of the steel they produce.

Annual Convention of the British Foundrymen's Association.

The following is the official programme of the forthcoming Convention at Cardiff of the British Foundrymen's Association, to be held on August 6, 7 and 8 next :—

Tuesday.

Morning, 9.30 *a.m.* (*open to members only*).—Minutes of Annual Meeting, 1911; election of officers; Mr. Buchanan's notice of motion *re* alteration of Annual Meeting.

10 a.m. (open to members and visitors).—Presidential address. Papers :—"Modern Brass Founding," by H. S. Primrose, Glasgow; "The Training of Apprentices," by J. W. Horne, B.Sc. (Edin.), Assoc. Inst.C.E., Erith; "Coking in South Wales," by R. H. Greaves, Cardiff.

Afternoon.—Visit to the Dowlais Works of Messrs. Guest, Keen & Nettlefolds, Limited. Trains will leave The Hayes, Cardiff, at 2.15 p.m.

Evening.—Reception by the Right Honorable the Lord Mayor of the City of Cardiff in the City Hall, Cardiff, at 7.30 p.m.

Wednesday.

Morning, 9.30 *a.m.*—Papers :—"The Influence of Sulphur on Cast Iron," by H. I. Coe, M.Sc., Birmingham; "Moulding a Water Jacketted Gas Engine Cylinder," by J. G. Robinson, Halifax; "Pattern Making," by R. H. Schofield, Manchester; "Moulding Sands," by A. B. Searle, Sheffield.

Advance copies of the Papers to be presented before the meetings may be had after July 20, on application to the Secretary.

Afternoon.—Visit to and around Cardiff Docks. Saloon carriages provided by the Cardiff Railway Company, will leave Rhymney railway station, Cardiff, at 2.15 p.m..

Evening.—Visit to the Penarth Docks and hydraulic houses. Train will leave Taff Vale Railway, Cardiff Station, at 6 p.m.

Thursday.

Picnic in the Wye Valley. Train leaves Cardiff Great Western Railway at 10 a.m., and arrives Symonds Yat at 12.36. Lunch at 1.0 p.m. Drives from Symonds Yat 2 p.m., *via* Moss Cottage and Tintern, and arrive Chepstow at 5.30 p.m. Tea at 6 p.m. Departure from Chepstow 7.5, or 8.29, arriving at Cardiff 8.37, or 9.32.

Members are requested to notify Mr. H. Griffiths, 70, Partridge Road, Cardiff, not later than Saturday, July 22, if they intend to join in the picnic to the Wye Valley, in order that proper arrangements can be made. Accommodation cannot be guaranteed for those who fail to give notice.

Special arrangements are being made for the ladies during the morning and afternoon business meetings, conveyances being provided for visiting places of interest in and around Cardiff.

Mr. J. Platt, who was intimately connected with Fielding & Platt, Limited, Atlas Works, St. Luke's Street, Gloucester, died recently at the age of 75 years.

Mr. J. P. W. Walker, formerly general manager of the Dalmellington Iron Company, Limited, has died after an illness of some duration. He entered the service of the Dalmellington Iron Company in 1874, and after twelve years in the drawing office was appointed general manager in 1886 on the death of Mr. John Hunter. He occupied that position for twenty years, and his resignation was much regretted.

Moulding a Test-Head Matching Piece.

By Sydney G. Smith.

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The accompanying drawings show the tackle and methods of moulding a test-head matching piece similar to that shown in Fig. 1. The diameter of

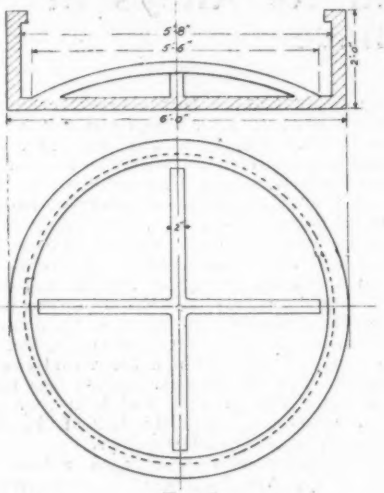


Fig. 1.

the matching piece depicted is 6 ft., the depth 2 ft., and the thickness 2 in. Four internal cross ribs, as shown, form part of the casting.

Fig. 2 shows a sectional view of the arrangement

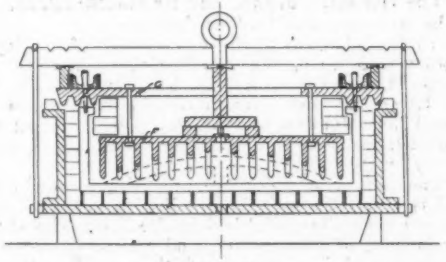


Fig. 2.

of the completed mould ready for pouring, while in Fig. 3 are shown the casing and mould board set.

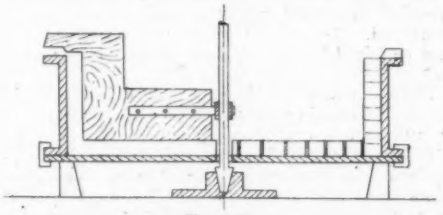


Fig. 3.

On the right is shown a section of the brickwork completed.

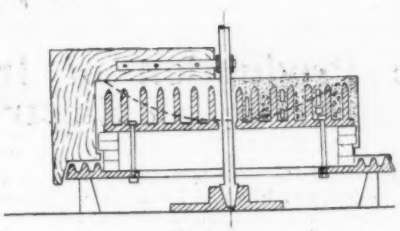


Fig. 4.

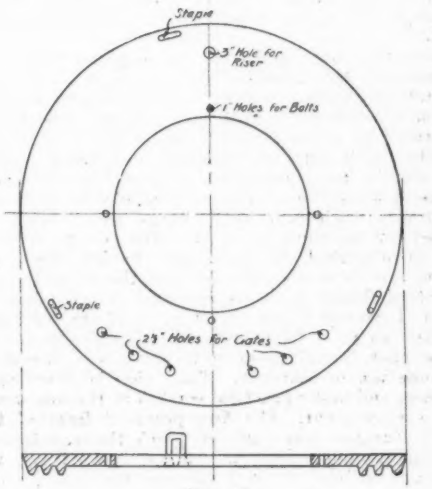


Fig. 5.

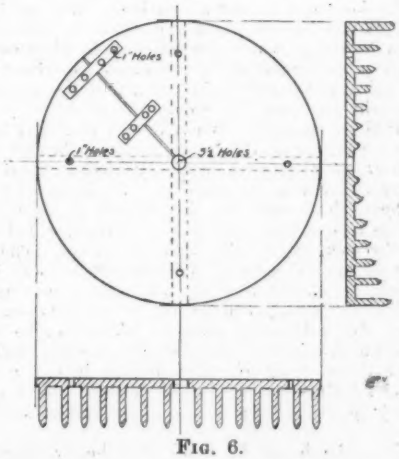


Fig. 6.

Fig. 4 shows a view of the cope formed, with two plates bolted together. The right-hand section of the sketch shows the half-mould finished.

In Figs. 5 and 6 are depicted the two plates which form the inside and top. The drawings should be self-explanatory.

When making this tackle no detail should be overlooked. The plate shown in Fig. 6 is cut through, with a thin strip of iron smeared with loam, from centre to the outsides. A solid plate of this size would fracture when drying if this precaution were not taken. Cutting through allows contraction and expansion to take place. The spring of the plate resulting from being cut is taken out by being patched and bolted as shown.

The Production of Iron and its Alloys in the Electric Furnace.

The subject of the electric furnace in its relation to the production of iron and its alloys was presented in a practical and most interesting way before the members of the Birmingham Branch of the British Foundrymen's Association on May 18, in a lecture given by Mr. J. H. Stansbie, B.Sc., F.I.C., of the Municipal Technical School. Mr. G. Hailstone presided.

Assuming that some of his hearers were not electricians, Mr. Stansbie commenced with a brief account of electro-magnetic induction for the production of current. This part of his subject he illustrated by means of one or two simple experiments and the exhibition and dissection of a small generator; and he then proceeded to show how resistance to the flow of the current caused electrical energy to convert itself into heat energy which could be utilised for metallurgical work. The system of units used in electrical measurements having been described, the lecturer explained that the kilowatt hour (Board of Trade unit) represented a quantity of electrical energy which would raise 22 lbs. of water 100 degrees C. To put it more practically to the ironfounder, 155 of these units would be sufficient to melt one ton of cast-iron. That was the theoretical estimate, and under practical conditions the loss would not be very great. The first practical form of the electric furnace was that in which the arc formed between two electrodes, as in the case of the arc lamp was utilised to heat the melting zone. The lecturer had before him a small laboratory arc furnace of the simplest form, consisting of two large firebricks, hollowed to hold a crucible. Having shown that to produce the arc the two carbons, or electrodes, must be touching when the current is switched on and afterwards separated, Mr. Stansbie explained that he was using a current of 74 volts, and the arc-space between the carbons was about 1½ ins.

Continuing, he said, "When two carbon rods forming the terminals of the leads from the bushes of a dynamo or an alternator are connected momentarily and then separated, the rush of current develops so much heat that some of the carbon is volatilised and forms a bridge of vapour across the gap between them, through which the current passes. The resistance of this vapour is so great that much heat is generated, and a temperature approximating to 3,500 deg. C. is attained in the space between the carbons. The minimum pressure which can be used to form an arc is 30 volts for alternating, and 40 volts for direct current. The region is the neighbourhood of the carbons is the hottest space it is possible to produce by any means at present at command.

"It is to be borne in mind that heavy currents under low pressure are the most advantageous for the generation of heat. The resistance of solids and liquids is mostly used in conjunction with the arc for electric smelting.

Having melted in the furnace in a small carbon crucible a charge of washed cast-iron and pure silicon, the lecturer proceeded, with the aid of blackboard diagrams, to describe some of the principal types of electric furnaces designed for practical work. The simple arc furnace, in its more generally used form, consisted of a vessel, having a very refractory carbonaceous material, which was also a conductor, underneath the material to be melted. A carbon block, suspended above the charge in such a way that it could be raised or lowered, served as the positive electrode. This was brought down so as to make an arc between the material itself and the carbon block, and the current passed through the actual charge in the furnace. The charge when melted was run out at the bottom. This principle had been very largely applied in America in the early days of the electric furnace for the making of ferro-alloys.

Electric furnaces could be arranged in four classes as follows:—(1) Arc furnaces; (2) resistance furnaces; (3) arc-resistance furnaces; (4) induction or transformer furnaces. Examples of all these types had been used for iron and steel smelting, but only those furnaces which had been in successful use would be mentioned.

The Heroult Furnace and its Modifications.

The lecturer continued as follows:—

"To Héroult must be given the credit of making a distinct step up in the application of the electric furnace to steel-making. He had already laid the foundation of the aluminium industry when he turned his attention to steel smelting. He had the arc-resistance principle clearly in mind, and applied it very successfully.

"The bed upon which the operation is conducted consists of a refractory non-conducting material, and the most generally useful is dolomite lime. The upper part is built of silica bricks, and the outer casing is constructed of iron plates, which are separated in parts so as to prevent the formation of a magnetic circuit. The electrodes consist of solid blocks of carbon which are connected with the leads from the current generator or transformer, and are so suspended that they can be readily raised or lowered as required. The whole structure is arranged so that it can be tilted for running off either slag or metal at will.

"The operation may be commenced in the cold furnace by introducing part of the charge of, say, pig-iron and scrap, and then lowering and raising the electrodes so as to form arcs between their lower ends, and the surface of the charge. The current is then conveyed from one electrode to the other through the charge itself, the resistance being largely furnished by the poor contact between the separate pieces in the bulk. In this way the necessary heat is developed for melting. When the charge is molten a slag is formed by the addition of lime and iron ore

which when melted form a blanket of liquid matter into which the electrodes just dip. Heat is mainly developed by the resistance of the slag, which decreases as its temperature increases. Thus its conducting power is greatest where it is in contact with the electrodes and falls somewhat between. It is possible to arrange the distance between the electrodes so that part of the current shall be conveyed by the slag and part by the bath of metal beneath. The temperature is, therefore, more or less under control. The electrodes do not come into contact with the molten metal, so that it cannot take up carbon from them, and this is an important factor in the refining. It may be noted here that the great feature in electric refining is the readiness with which the composition of the slag may be varied. Thus, it may be made oxidising, neutral, or reducing at will, and as it can be removed and a fresh slag formed, the refining can be carried to the highest limit. After refining, additions can be made and alloys of any desired composition produced.

"Thus the Société Electro-Métallurgique Française make ferro-chrome, ferro-tungsten, ferro-nickel, and ferro-silicon in their Héroult furnaces at Froges and La Praz; and Dr. Héroult states that he can make steel practically free from silicon, sulphur, and phosphorus, and containing from 0.02 to 2 per cent. of carbon. Such metal can be cast sound, and is of tool-steel quality. Furnaces up to 5 tons capacity are in use."

In the Girod* modification of the Héroult furnace, the current, instead of passing only, or in greater part, through the slag, was made, by a system of multiple electrodes distributed round the arch, to pass more or less uniformly through the whole of the bath, so as to get a more uniform distribution of the heat. This furnace was doing good work, but all modifications of the original furnace had to undergo the test of experience.

The Hering Pinch-Effect Furnace.

"It is well known that a contraction in the cross-section of a liquid conductor takes place when a current is passing through it. This is due to electro-magnetic force, which acts from the circumference to the centre of the column, thus producing a kind of pinching action. Hering has taken advantage of this effect in the construction of his furnace.† The solid-metal electrodes described above are replaced by tubes constructed in the bed-lining of the furnace, and lined with refractory material. The bottoms of these "resistor" tubes, as they are called, are closed by hollow water-cooled plugs which are connected up with the current supply. There are usually two of these tubes, but with three-phase current three may be used. In order that the furnace may work, the resistor tubes must be full of molten metal, and also connected with each other by the motlen bath. When the current is passing the pinch effect causes the metal in the tubes to rise up the centre and fall down the sides, and in this way a circulation is set up which not only keeps the bath of metal in motion, but also helps the distribution of heat through it. Just over the tubes the surface of the slag is lifted up as though the metal underneath were being bumped up against it. This gives the bath somewhat the appearance of boiling, although no bubbles escape. Such an action must evidently assist the refining."

Another furnace described by the lecturer was the Nathusius.‡ One of these, with a capacity of six tons, had been in constant operation for eighteen months. The Nathusius was a further modification of the Girod. Three-phase current was utilised by Nathusius in his furnace, which was an arc-resistance furnace. The current circulated not only through the bath of metal, but also through the dolomite lining, which became somewhat conductive at a high temperature. The passing of the current through the bottom of the bath, and so securing a more uniform temperature throughout the charge, appeared to him (the speaker) the principal advantage of the Nathusius furnace. This furnace certainly appeared on the face of it to give more uniform results than could be got with those previously described.

"The electric furnace as a simple melter cannot be used economically, so that when part of the charge can be run into the hot furnace in the molten condition, considerable saving is effected. This has been carried out with the partly-refined metal from the mixer and also from the Bessemer converter, but it involves the tapping of the metal and its transference by ladle to the electric furnace in both cases. Messrs. Verdon, Cutts & Hoult, of Sheffield, have, however, succeeded in combining the two processes in one vessel, and their furnace will make its mark in the future." *

The Arc Furnaces.

"There are very few arc furnaces, pure and simple, used on the large scale, and of these the Stassano furnace has proved the most successful for iron and steel work. It is, however, more costly to work than the furnaces already described, and can only have a limited application. It was taken up by the Italian Government, and used for the production of gun-steel. The furnace is circular in cross-section and has a dome roof. The furnace space is lined with refractory material, and the carbon electrodes enter it about midway between the floor and roof. They are fitted with regulating gear by which they can be caused to meet in the centre of the chamber, or their ends may be brought flush with the walls. There are tap holes for metal and slag, one near the bottom of the hearth and the other midway between it and the electrode openings. The whole structure is mounted on an axis slightly inclined to the vertical, so that one side of the hearth is always a little lower than the other when it is in rotation. The electrodes rotate with the chamber, and contact with the power leads is kept up by an arrangement of brushes connected with the axis at the top of the chamber. The charge is heated entirely by radiation from the arc space and the side walls of the chamber. Furnaces of various sizes have been built; but one with a chamber about 3 ft. in diameter and 3 ft. high will take a current carrying energy at the rate of 456 h.p., *i.e.*, 2,000 amperes at a pressure of 170 volts."

The Induction Furnace.

"The construction of this furnace is quite distinct from that of any of the foregoing, as it is worked entirely without electrodes. It is in its original form a step-down transformer, and was first introduced by Ferranti. The most successful of the early furnaces of this type is that constructed by Kjellin at Gysinge Bruk, in Sweden. In principle a step-down transformer consists of a continuous ring or core of soft iron enclosed in a coil of insulated thin copper wire of many turns. This primary coil is surmounted by a coil of insulated thick copper wire of few turns, which forms the secondary circuit, and is quite separate from the primary one. If now light alternating currents at high pressure are sent through the primary coil, heavy currents at low pressure are induced in the secondary coil when its

* See Foundry Trade Journal, March, 1910, page 150, and June, 1910, page 297.

† Ibid, May, 1912, page 295.

‡ Ibid, December 1911, page 641.

* Foundry Trade Journal, June, 1910, page 317.

terminals are connected. The ratios between current and pressure in the two coils follow a simple law. Thus, supposing the primary coil to consist of 1,000 turns and the secondary of 10 turns, and that the primary were carrying a current of 100 amperes at 3,000 volts, then the induced current in the secondary would be 10,000 amperes at a pressure of 30 volts. There are, of course, energy losses in the transformer, but these are comparatively small.

"It has been remarked already that heavy currents at low voltage are the most suitable for heat production by resistance. Now, suppose the secondary coil above to consist of one turn only, and that its cross-section be limited so as to offer sufficient resistance to the passage of the heavy induced current through it, the possibility of its being melted becomes evident. This is the principle of the induction furnace, in which the metal to be treated forms the secondary coil of one turn in the transformer.

"In the Kjellin form the furnace is circular in section, and the hearth consists of an annular space in the masonry lined with either acid or basic material, and provided with a tap hole and cover which is made in sections, so that any part of the hearth can be readily inspected. A massive soft-iron core, made up of thin plates and rectangular in form, is arranged so that one side passes through the centre of the circle of which the hearth forms the boundary. This is surrounded by the primary coil of many turns, the terminals of which are connected with the leads from the generator. In actual working it is necessary to protect the coil from the heat of the masonry when the furnace is in full work, and this is done by surrounding the coil by a closed chamber through which cold air can be forced by a compressor plant. Many objections have been urged against this form of furnace, but it has been in successful operation for 12 years, and for some kinds of work is undoubtedly the best.

"In working the furnace it is necessary to start with a ring of molten metal in the hearth, so that when the primary current is switched on the transforming may commence at once. The heat thus generated in the ring raises its temperature, and additions of cold metal may now be made until the full charge is added. Refining is carried on by the addition of ore and slag-forming material, and when this is finished additions of ferro-alloys may be made for the production of special steels. The charge in the hearth is caused to rotate rapidly under the magneto-electric forces at work. This has its advantages in producing mixture of the charge and contact with the slag, and its disadvantages in that it causes splashing of the slag against the side walls of the hearth, and causes more rapid corrosion than would take place in a still bath. But from the fact that no electrodes are used and that the heat is generated in the body of the metal itself, it is possible that by the use of suitable materials, products of a high degree of purity may be obtained, and in this respect the furnace has an advantage over every other form.

"To give an idea of the power required to work such a furnace, it may be stated that one having a capacity of 35 cwts. can be worked by an alternating current of 80 to 90 amperes at 3,000 volts, which is stepped down to 30,000 amperes at 7 volts in the hearth. The energy thus absorbed is equal to 282 h.p. The most important modification of this furnace yet introduced is that found in the Röchling-Rodenhauser furnace, which is best described as an induction-resistance furnace."*

Using an experimental furnace into which, through a hollowed carbon, he introduced a rod of steel, the lecturer showed how, by allowing the steel to project into the space usually occupied by the arc, the metal almost instantly became fused. This furnace was open at the bottom and with a vessel of water placed beneath to catch the particles of steel, he illustrated Moissant's experiments in the production of artificial diamonds. The lecture concluded with lantern views of electric furnaces of various types.

MR. MORGAN, in proposing a vote of thanks to Mr. Stansbie, said that the lecture had been most interesting. As foundrymen, they were, many of them, too much occupied with their special work to follow closely what was going on in other fields. The lecture had taught some of them how little they really knew. After what they had heard they could not have any doubt that ultimately electricity would play a great part in foundry work generally. Mr. Richards seconded the vote of thanks, which was carried by acclamation.

* Foundry Trade Journal, July, 1909, page 415.

Adding Aluminium to Yellow Brass.

According to "The Brass World," the benefit of aluminium in yellow brass has now been thoroughly demonstrated, and with the exception of goods such as plumbers' brass goods and valves, which have to stand pressure, it is very largely used in making yellow-brass sand castings. It renders the castings sounder and free from pinholes to a marked degree. The brass runs sharper, more pieces can be put on a gate, and the castings come out of the sand cleaner.

The natural method of adding aluminium to yellow brass is to introduce it into the brass just before pouring. This is the method generally used, but is open to the objection that the amount of aluminium used is so small that it is difficult to alloy it with the brass, and it is apt to float on the top of the melted metal and waste; and also that the aluminium causes the brass to "flare," on account of the heat generated in the alloying, and is apt to waste the zinc. This latter objection is not a serious one except when considerable aluminium is to be added; but the first objection is an obstacle when certain results are to be obtained.

The best method of adding the aluminium to yellow brass is to make a rich alloy of zinc and aluminium by melting them together and breaking up into small pieces. Zinc 7½ lbs., and aluminium 2½ lbs., give an alloy containing 25 per cent. of aluminium. This is added to the brass just as zinc would be added, and to obtain any desired weight, simply take four times the amount of the alloy of zinc and aluminium. This alloy, it may be mentioned, is frequently called "aluminised-zinc."

If, for example, it is necessary to add 2 ozs. of aluminium to brass, take 8 ozs. of the alloy; and then take 8 ozs. less of zinc in the mixture. For ordinary work, however, it will not be necessary to take any account of the zinc, as it will practically make up for the loss in melting. All that is necessary to do, therefore, is to add four times the amount of the aluminium needed in the form of the zinc and aluminium alloy. The use of this zinc and aluminium alloy instead of pure aluminium will prevent flaring, and render it always certain that the right amount of aluminium is introduced into the brass. With the regular method of adding the aluminium alone, it is not positive that it all goes into the metal.

For ordinary yellow-brass work, from 2 to 3 ozs. of aluminium are used, and this means that from 8 to 12 ozs. of the aluminium-zinc alloy are required. If more is added, the brass becomes harder and is apt to shrink considerably. If less is used, then the full value of the aluminium is not obtained.

Exhibition of Non-Ferrous Metals.

The Exhibition of Non-ferrous Metals at the Agricultural Hall, Islington, which was open from June 15 to June 28, was the first of its kind, and in view of that circumstance, was the object of considerable interest, for although the available space was by no means fully occupied, there were over sixty stands, many taken by manufacturers who may be regarded as quite representative of their particular line of business, and most of whom made an excellent display.

The opening ceremony was conducted on June 15, and at the luncheon which formed a function of the occasion, and at which a large number of guests were present, several prominent men in the metallurgical world spoke. The President of the Exhibition, Sir Gerard A. Muntz, Bart., presided.

Prof. W. C. Unwin, F.R.S., in proposing "Success to the Exhibition," said that while to iron was largely due the past prosperity of the country, the future lay well with the non-ferrous metals. The position of the steel industry to-day was largely dependent on the non-ferrous metals; while aluminium, as an example, was taking a place of great importance in the industrial world.

Sir Gerard A. Muntz, replying, discussed the necessity of coming into the daylight and showing fellow-workers what was being done, so that mutual benefit might result. He remarked that "The man who thinks he knows more than another, generally does not know as much as he thinks he knows"—a truism which evoked some laughter and applause. Continuing, the speaker referred to the lack of assistance in the direction of consular service which characterised British Governments generally in respect to British manufacturers and the development of foreign trade. He instanced the example of Germany and America to show how manufacturers in those countries were being aided to compete in foreign markets.

The Exhibits.

One of the most interesting stands was that of Thermit, Limited, a prominent feature of which was a collection of metals and non-ferrous alloys which are being employed in foundry work. The most important of these were the following:—Chromium (about 98-99 per cent. purity); chromium-copper (10 per cent. Cr.); manganese (about 96-97 per cent. purity); chromium copper (10 per cent. Cr.); manganese (about 96-97 per cent. purity); manganese copper, free from iron (30 per cent. Mn.); molybdenum (98-99 per cent.); ferro-molybdenum (80 per cent. Mo.); molybdenum-nickel (75 per cent. Mo., 25 per cent Ni.); ferro-vanadium; vanadium-copper (8-9 per cent. Va.); and ferro-titanium (20-25 per cent. Ti.). About a dozen other alloys also figured on the stand. An interesting feature was a number of fractured test pieces of the "S.A.B." alloy, a special brass alloy which easily alloys with brass at a low temperature. By adding this alloy, various elements in a definite percentage can be introduced into the copper and zinc bath. If 8 per cent. of this alloy be added to brass containing 60 per cent. copper and 40 per cent. zinc, special brass will be obtained having a tensile strength of 33 tons per sq. in., and an elongation of 30 per cent. The product has a golden yellow colour, and is distinguished by its great resistance to atmospheric influences, to acid and alkaline solutions, and also to sea and mine water. It can easily be worked, forged, rolled and pressed. The molten metal readily fills up the moulds, and, as shown by its great elongation, the casting is more tenacious, is free from pores, has an uniform grain, and shows a regular fracture. Specimens of manufactured articles containing some of the special constituents exhibited were also shown, including some of high-speed tool steel, made with pure chromium, pure molybdenum, and ferro-manganese; while an interesting item was a mild steel bar displaying a weld by the alumino-thermic process. This bar was 8 in. by 6 in., and showed a perfectly homogeneous weld. The bending test on a companion bar unwelded under an 80-ton load, gave a deflection of 9.34 in. and 8.66 in. permanent set, while the corresponding figures for the welded bar were 7.52 in. and 6.95 in. The Company also displayed an exhibit of Goldschmidt standard tin of about 99.8 per cent. purity, as produced by the Th. Goldschmidt A.G., Essen-Ruhr, Germany. One of the most attractive features of the stand, from the popular point of view, was a cinematograph representation of alumino-thermic welding, and the application of titanium-thermit for foundry purposes.

Aluminium and Rolled Metals.

As a testimony to the important position which aluminium has made for itself, not only as a rolled product, but also as a foundryman's metal, was the exhibit of the British Aluminium Company, Limited. A very comprehensive display of the aluminium alloys in all forms was made, and not the least interesting were some really excellent examples of cast work. In the centre of the stand was a handsome show-case constructed of polished aluminium mouldings and containing some fine samples indicating the various stages of manufacture, and a few of the manifold applications of the metal. Here were to be seen ingots, rolling-slabs, and wire and tube billets rough from the moulds, in close proximity to polished and frosted sheets, tubes, wires, and bars. Lamp reflectors were also shown spun in the most attractive shapes; while the electric light fittings were also of aluminium. A feature of the decorative scheme of the stand was an array of solid-drawn aluminium tubes suspended in graduated sizes on either side.

Among the most attractive stands displaying drawn and rolled products may be mentioned those of Muntz's Metal Company, Limited, Earle, Bourne & Company, Limited, James Booth & Company, Limited, and the Delta Metal Company, Limited. The first-mentioned of these companies had an excellent exhibit of tubes in brass, copper and aluminium of various sizes, grouped in columns supporting a roof sheathed with Muntz's patent metal, as used on ship's bottoms, and the stand included a variety of the Company's manufactures, such as brass bolts and nuts for engineering purposes, specimens of manganese bronze, a number of alloys in the form of nuts, bolts, pump rods, etc.; also condenser tubes and copper pipes for marine purposes. The exhibit of Messrs. Earle, Bourne & Company, Limited, included many articles produced by this firm in sheet metals, tubes and wires, and illustrated the great variety of sections and ornamental work done by them in the different grades of metals, in brass, copper, German silver, etc.

Among the alloys which attracted much attention at the Exhibition, was "Duralumin," manufactured by Messrs. Vickers, Limited. This remarkable alloy of aluminium has already been referred to in

our columns at some length; but it may be pointed out that the Company claim to have been successful in producing a metal as strong as steel and as light as aluminium. In regard to the former point, we understand that it is now being used for parts of motor vehicles and railway carriages, formerly made of steel; and in regard to the latter, its specific gravity, this is stated to be only 2.8 as compared with 7.8 in the case of steel. The capacity of "Duralumin" to withstand most successfully the action of sea-air and sea-water has also opened up for the material a special field; its light weight, combined with its strength making it of marked interest for all those who directly or indirectly are connected with the shipbuilding trade.

Anti-Friction Metals and Castings.

Among the anti-friction metals exhibited were those manufactured by the Eyre Smelting Company, Limited, and shown in ingot form. This Company were also represented by examples of Bamber's non-encrusting zincs for primary batteries. The Glacier Anti-Friction Metal Company, Limited, exhibited various qualities of white metal alloys, including some for the bearings of high-speed and heavy-pressure machinery, as well as others for use in bearings of internal combustion engines, and others again for working under slow speeds and moderate pressures. Another feature of the stand was a display of die-cast bearings, which are cast solid from Findlay's special metal No. 1, and which are now extensively used in the motor industry. Messrs. Cookson & Company, Limited, Newcastle-on-Tyne, had an imposing exhibit of antimony, antimonial leads, type metals, alloys, and all descriptions of manufactured leads. A striking feature of the exhibit was the display of a large block of pure Star Antimony, weighing considerably over a ton and measuring in its case 5 ft. 8½ in. by 4 ft.

Other exhibits of anti-friction alloys, etc., which may be mentioned were the following:—The Atlas Metals and Alloys Company, Limited (specimen ingots of their various qualities of anti-friction metal, the Hoyt Metal Company of Great Britain, Limited (a number of alloys and lining metals for bearings, and also a number of die-cast bearings); the Yorkshire Engineering Supplies, Limited (phosphor-bronze and whitemetal alloys); Dewrance & Company (samples of anti-friction bearing metals, and also various samples of bearings, lined and unlined and examples of old bearings which have been relined with this firm's metal); the Tandem Smelting Syndicate, Limited ("Tandem" metals and special alloys).

The latter Company had also a working exhibit of liquid fuel appliances, including the Höveler oil-fuel burner which was recently described in our columns. Castings of different descriptions were shown by, amongst others, the Light Alloy Company, who are the selling agents for "Vanalium," the light engineering metal, and who made a display of castings in "Vanalium" of various sorts; and also Robt. W. Coan, who showed a general selection of aluminium castings for engineering and other purposes. The Sulphalium Metal Company also had a most interesting collection of intricate castings, made from their new aluminium alloy "Sulphalium," and cast at their own foundry.

Bell metal and some fine specimens of bell castings were shown by Charles Carr, Limited, the well-known Smethwick bell-founders. One bell shown weighed half a ton, and was fitted up in an iron frame of new design. Other exhibits by this firm were anti-friction metals of many grades and qualities, including copper-hardened motor babbitts, phosphor-tin, phosphor-copper, and phosphor-bronze, together with samples of chill-cast phosphor-bronze bars for motor work. Castings in brass, gunmetal, and phosphor-bronze, and Carr's well-known patent crucible melting furnaces were also shown, and a special design of furnace, as supplied to the Royal School of Mines, London, also to the Technical Schools at Birmingham, Manchester and Liverpool.

Other Exhibits.

An exhibit of considerable interest to brass-founders was that of the Rapid Magnetting Machine Company, Limited, who showed one of their "Standard" type and size electro-magnetic separator for removing iron from brass borings, turnings, dust, etc. The chief feature of this separator is that it will successfully treat a mixture of 99 per cent. of iron or steel, and only 1 per cent. of non-magnetic material, thus insuring absolutely no waste of the valuable metal. Another machine shown was type "A" rapid electro-magnetic separator, which is also suitable for treating brass borings, turnings, etc., and brass washings from caster's ashes. A useful apparatus also exhibited was their "Rapid" scrap tester. This consists of an exceptionally powerful electro-magnet, which is placed on the sorting bench. In order to detect the presence of iron which may be entirely hidden, all that is necessary is to place the piece of scrap against the magnet, when the presence of iron will be immediately detected.

The Berndorf Metal Works, Birmingham, had a fine display of nickel goods, including pure nickel in anodes, sheets, wires and tubes, German silver, Thio and Alpacca brands, in sheets, wires, tubes, etc., and some remarkable specimens of drawn work in German silver. Other firms' exhibits were as follows:—The International Vanadium Company, Limited (raw materials and manufactured products of vanadium, uranium and titanium); the British Mining and Metal Company, Limited (a series of alloys for engineers, known as "Britaresist"); the Anglo-French Nickel Company, Limited (nickel and cobalt ores and products); the Delta Metal Company, Limited (extruded rods and specialities for engineering); Messrs. Geo. Schultze & Company (flexible metallic tubing without seam or joint); Messrs. Henry Wiggin & Company, Limited (nickel, cobalt, and other alloys); Messrs. H. Ost & Company (carbon-free metals and alloys); Messrs. Huntington, Heberlein & Company, Limited (continuous recuperative furnaces); and the Ribbon Metals Syndicate, Limited (Babbitt's and other anti-friction metals in ribbon and strip form).

Scientific instruments were displayed by Carl Zeiss (London), Limited, who exhibited and demonstrated a micro and photo-micrographic outfit for the investigation of structures in metal and alloys with low medium and high power; and also Mr. E. Leitz, who showed a good selection of microscopes and other instruments.

The Stock Oil-Fired Converter.

It is announced that the Canadian Steel Castings Syndicate is proposing to erect a plant at Hamilton, Ontario, on which £60,000 will be expended as a beginning. The Syndicate has the exclusive right for Ontario for the Stock oil-fired converter. In addition, the plant will be equipped with a 20-ton open-hearth furnace for the manufacture of heavy steel castings. Tenders will be asked for immediately. The main building will be in one storey, 520 ft. by 160 ft. The cleaning building will be 400 ft. by 60 ft. The plans are being prepared by Messrs. Prack & Perrine, of Hamilton, who will have charge of the construction and the installation of equipment.

The British Foundrymen's Association.

Annual Report for 1911.

The Annual Report for 1911 of the Council of the British Foundrymen's Association states that the Literary Committee are now reviewing the Papers given during the past session, and the awards for the best will be published shortly.

The Council have pleasure in reporting that the Branches are doing excellent work. Two new Branches have been formed—Halifax and Newcastle-on-Tyne. Mr. H. Campbell, M.I.M.E., of Messrs. Campbell Gas Engine Company, Halifax, was elected President of the Halifax Branch and Mr. Wallis of the Wallsend Engineering Company, President of the Newcastle Branch. Both Branches are doing well, much enthusiasm being shown amongst the members.

The respective Branches have the following members attached to them :—

	Members.	Associate members.	Associates.
Birmingham	22	91	90
Halifax	15	43	61
London	40	48	8
Lancashire	29	77	21
Newcastle-on-Tyne	15	13	12
Sheffield	75	53	14
Scottish	19	83	44
Non-Branch Members ...	28	26	—

The Council regret that Mr. H. Sherburn, of Warrington, has resigned the Secretaryship of the Lancashire Branch. Excellent work for the Association has been done in Lancashire, and the Council thank Mr. Sherburn for the zeal displayed and the indefatigable work done during his term of office. Mr. A. Harrison, of Messrs. Tweedales & Smalley, Limited, Castleton, Lancs., has taken up the office of Secretary for that Branch.

Mr. J. A. Ewan, Secretary of the Scottish Branch, has gone abroad, and Mr. M. Riddell, Etna Ironworks, Falkirk, has taken up the office of Interim Secretary.

The Council regret having lost one of their colleagues through Mr. Mason going out to Australia. Mr. Mason has been a Council member since the formation of the Association, he being one of the twelve gentlemen who first joined together to form that Association. He is a Past-President of the Birmingham Branch, author of many valuable Papers given before the members, and the energy and time he has devoted to our interests, have greatly helped to bring the Association to its present position.

Twenty-eight Papers have been given during the past session, and very interesting visits to works have taken place. The Council desire to thank the proprietors for their kindness in allowing these visits, also the gentlemen who have kindly given Papers during the session.

The number on the roll of the Association at the present time is 889, consisting of 7 Hon. Life Members, 5 Life Members, 193 Members, 434 Associate Members, 250 Associates, compared with a total number of 674 for the year 1911. Four Members, 12 Associate Members have resigned or ceased to be members, and 42 Members, 86 Associate Members, 103 Associates have been elected.

The accounts for the year ending December 31, 1911, are now submitted, having been duly certified by Messrs. M. Riddell and C. Mace, the auditors appointed by the Council. The total revenue for the year was £412 13s. 1d., and the expenses £318 6s. 7½d., leaving a balance of revenue over expenditure of £94 6s. 5½d. This, with a balance of £102 0s. 8½d. brought forward from the year 1910, leaves a balance in hand of £196 7s. 2d. It will be noticed that the account for the printing of the Annual Proceedings for 1911 is not included in the balance sheet, as this is not yet to hand.

Six members of the Council are retiring, and, with the exception of Mr. Mason, who has gone abroad, are eligible for re-election.

The following gentlemen have been nominated :—Messrs. T. Macfarlane (Messrs. The Horsehay Company, Limited, Shropshire); T. H. Firth (Messrs. The Brightside Foundry and Engineering Company, Limited, Sheffield); G. B. Henderson (Messrs. J. I. Thornycroft & Company, Limited, Southampton); W. H. Hatfield (Messrs. Crowley & Company, Meadow Hall Ironworks, Sheffield); J. Oswald, M.I.Mech.E. (Sleaford Foundry, Nine Elms Lane, London); F. C. Pulsford (Messrs. Ashwell & Nesbit, Leicester); J. Smith (South Shields); and W. H. Sherburn (Stockton Heath, Warrington).

"F.T.J." Bookshelf.

General Foundry Practice.

By Andrew McWilliam, A.R.S.M., M.Met., and Percy Longmuir, B. Met. London : Charles Griffin & Company, Limited, Exeter Street, Strand, W.C.

When the first edition of this work on foundry practice appeared it met with considerable approval, as bearing the stamp of actual foundry experience combined with scientific knowledge; and it at once found a place in the front rank of English foundry text books. It is not surprising, then, to find a second edition now appearing, since it represents so ably first-class modern practice from a really practical standpoint. Not only is the work suitable for the foundry manager and works engineer, but it is compiled in a straightforward style which appeals to the working moulder also. It will, of course, be understood that any work by these authors does not neglect the technical and scientific side in favour of the practical, the volume before us being a very judicious mingling of both without being above the head of the man lacking much scientific education. It is perhaps unnecessary here to detail the scope of the work, but we may state that the first edition is followed closely. At numerous points additional matter and illustrations have been added, and the text generally has been revised and brought thoroughly up-to-date. All sides of foundry work, plant and materials come under survey, from the moulder's small tools to the cupola itself. Foundry materials, *i.e.*, moulding and core-making sands and metal, are discussed in turn, and each category of foundry plant and equipment is well treated. On the question of moulding the authors, of course, discuss the different classes of work, green-sand, dry-sand, and loam moulding, machine moulding also coming in for considerable attention. Following the chapters dealing with the foregoing and other phases of foundry practice, brief attention is paid to the properties of malleable cast iron, cast steel, grey cast-iron, and wrought iron. Attention is also turned to mixing by analysis, working the cupola, the further treatment of cast-iron, temperature measurement, mechanical testing, foundry management, and a number of other topics. Some notes on alloys form one useful chapter. The book forms an excellent survey of foundry practice, while also embodying a mass of useful information on all sides of the work. It may be accepted as very suitable for foundry students of all grades, from the apprentice to the general engineer, since it shows very clearly the relation between the scientific and practical sides of foundry work.

Inventions.

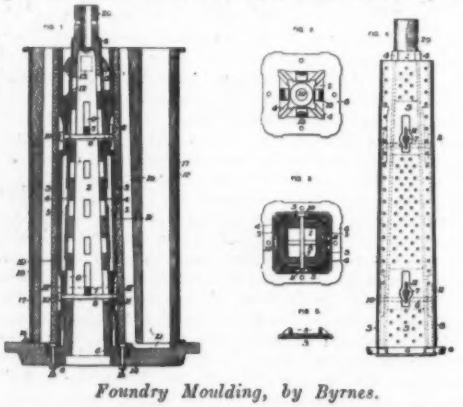
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

12,542.*Composition for treating cast-iron and steel. J. R. C. Marsh.
12,548. Metal tubes. Emil Witzmmann.
12,869.*Treatment of metals or alloys to render them ductile and malleable. Westinghouse Metallfaden Glühlampenfabrik G. M. B. H.
12,924.*Moulding plants for wrought-iron pulley bosses. R. H. Morris.
12,932. Utilisation of heat contained in molten slag, metal, etc. S. B. B. Hebb and Slag Power, Limited.
12,033. Gear wheel grinding machines. F. A. Ward and Gear Grinding Machine Company.
12,034. Shaft grinding machines. F. A. Ward and Gear Grinding Machine Company.
12,066. Furnaces for melting and alloying metals in vacuo. W. Simpson.
12,113. Making moulds for casting baths, cisterns, tanks, gutters, etc. W. Dennison.
12,168.*Process for refining copper. W. S. Rockey and H. Eldridge.
12,349.*Furnaces for metallurgical purposes. J. A. Hill.
12,402.*Draught reverberatory gas furnace for heating metals. Fletcher, Russell & Company, Limited, and T. W. Fletcher.

Abstracts of British Patent Specifications recently accepted.

10,330 (1911). *Foundry Moulding.* C. P. Byrnes, Sewickley, U.S.A.—Fig. 1 is a vertical sectional view showing an improved ingot mould; Fig. 2 is a top plan view of the core barrel; Fig. 3 is a cross-section on the line III—III of Fig. 1; Fig. 4 is a side elevation of the core barrel; Fig. 5 is a cross section of one of the movable plates of the core barrel. 2 represents the central stem of the core barrel, which is shown as substantially rectangular in cross section and tapering from the bottom toward the top. This stem is preferably hollow, and is provided with a series of perforations to assist in venting. The sides of the core barrel are formed by four



Foundry Moulding, by Byrnes.

plates 3, which preferably seat against corner ribs 4 of the stem to provide air spaces shown at 5 between the plate sides and the stem. The lower ends of these plates rest upon flanges 6 projecting from the base of the column 2, and are preferably secured by internal cross-bolts 7, 7 and 8, 8. These bolts are at two different levels, and extend through vertical slots 9 in the column to allow movement of the plate sides and column relative to each other, while holding the plates on the stem. The plates are shown as externally recessed to receive the heads 10 and the securing cotter pins 11 of these bolts. The column and slide plates thus form the collapsible core barrel, which is expanded or collapsed by endwise movement of the plates and column relative to each other. This core barrel as a whole is secured to the drag 14 of the mould by any desirable securing means. The drag is preferably provided with the centreing pins 16, which centre the flask 17 thereon. 18 represents the lining of the flask, and 19 the moulded covering for the core barrel. The central stem 2 projects above the plate sides of the core barrel, and also above the flask, as shown at 20, thus providing for easy extraction and stripping. In the use of the stripping device the sides of the barrel are preferably treated with a clay wash, and the core box put in place, and the core rammed up. The core thus formed, and the drag attached to it, are removed, a face of blacking applied and the cores dried in the core oven. The flask is rammed up in the usual manner, and the parts assembled as shown in Fig. 1. In this figure, 21 represents the pouring gate, which extends through the drag and communicates with the runner of the flask. When the mould has been cast, the core barrel is extracted from the mould, the central head of the stripping device bearing on the column, while the flask is stripped upwardly from the core. In this action, the side plate portions of the core barrel rise with the casting, and as they travel over the tapered part of the column they collapse inwardly. Their upward movement is stopped by the shoulders 12 meeting the lugs 13 of the column, whereupon the flask is further lifted off with its contained ingot mould casting and the plate portions drop back on the column. When the flask and casting have been removed, the core barrel and drag are lifted as one piece and taken to the moulding room, where they are again prepared for the next mould.

27,400 (1911). *Production of High Grade Steel and Slag Rich in Soluble Phosphates in an Open Hearth or Electric Furnace.* Deutsch-Luxemburgische Bergwerks- und Hütten-Aktiengesellschaft, of Bochum, Germany, and Albert Vogler, 67, Kaiserstrasse, Dortmund, Germany. In all metallurgical processes it is of importance to restrict as much as possible all auxiliary operations, such as the removal of slag. According to the present invention this is effected by so conducting the process that the tilting is effected simultaneously with the blowing operation, whereby the time for the removal of the slab is considerably shortened. It has been found that in effecting the tilting and blowing simultaneously, the whole mass of slag is immediately brought into liquid condition, and passes through the tapping hole in the form of a thick jet or stream. In this way, by means of this simultaneous tilting and blowing operation, the quantity of slag of a metallic charge of about 60 tons may be entirely removed from the metal bath in less than 8 minutes.

Co-partnership Bill.

A Bill on the subject of co-partnership has been introduced into Parliament by Mr. James Hope. In a memorandum accompanying the text of the Bill, the promoters state that the measure represents a tentative effort to encourage the principle of co-partnership in the industrial life of the country. The main objects of the Bill are:—(1) To enable companies to adopt co-partnership in cases where they would otherwise be debarred from doing so, either by their private Acts of Parliament or their articles of association; (2) to set out in the form of a schedule a model scheme of co-partnership for their voluntary adoption; and (3) to provide that such model scheme shall ordinarily be a condition for granting statutory power to new companies to raise capital, though, of course, without attempting to fetter the discretion of Parliamentary Committees in individual cases. Under this scheme certificates of partnership in the objects of the company and a share in its surplus profits are to be granted to all persons in its regular employment. It is provided that the standard rate of wages shall be taken to correspond with a standard return of 5 per cent. on all paid-up capital, and when the return is higher than 5 per cent. the employé becomes entitled to a bonus calculated at one-twentieth of his existing wages for every extra 1 per cent. paid in dividend.

Trade Talk.

Messrs. Geo. Scott & Company, engineers, have removed to 43a, Church Street, St. Helens.

Mr. F. Patrick, engineer, 15, Oxford Street, Leeds, has removed to Grosvenor Works, Blackman Lane, Leeds.

Mr. James McKidd, Thurso Foundry, Millbank Road, Thurso, has given up business, and the works have been dismantled.

The Kilmarnock Dean of Guild Court have passed plans for extensions of the engineering works of Glenfield & Kennedy, Limited.

Mechan & Sons, Limited, of the Scotstoun Ironworks, Scotstoun, Glasgow, are taking up the manufacture of conveying machinery.

Messrs. Fyfe, Wilson & Company, engineers' agents, 145, Bath Street, Glasgow, have removed to 155a, St. Vincent Street, Glasgow.

Wilsons & Mathiesons, Limited, of Leeds, have appointed Mr. W. C. Bryant, 42, Main Street, Birmingham, as their Midland agent.

Messrs. F. R. Harrison and F. G. Turner, carrying on business as engineers, at Cheapside, Hull, under the style of Harrison & Turner, have dissolved partnership.

Thomas Smith & Company, Limited, ironfounders, of Emmett Street, Poplar, London, E., will in future, in addition to their ironfounding business, deal in scrap metals.

The new works which Stewarts & Lloyds, Limited, propose establishing at Mossend, near the company's Clydesdale Works, are for the manufacture of solid-drawn steel tubes.

Robert Warner & Company (Engineers), Limited, Walton-on-the-Naze, have appointed John J. B. Cross & Company, Limited, Broad Street House, New Broad Street, E.C., as their sole London agents.

Messrs. C. Stephens and T. Clayton, carrying on business as engineers and manufacturers at Mill Works, Roden Street, Ilford, under the style of Stephens, Clayton & Company, have dissolved partnership.

An outbreak of fire occurred on June 10 at the Midland works of Bromley, Fisher and Turton, Limited, crucible steel manufacturers, Shoreham Street, Sheffield. The flames were extinguished before much damage was done.

The Sandycroft Foundry Company, Limited, of Sandycroft, near Chester, have granted to Messrs. Siemens Schuckertwerke, of Berlin, a licence for the manufacture of "Sandycroft-Hunt" Cascade motors in Germany.

The British Westinghouse Electric and Manufacturing Company, Limited, have taken more extensive offices at 179, Wardour Street (off Oxford Street), London, W., in consequence of the expansion in their London supply business.

Mr. G. P. T. Brown, 8, Lorimer Place, Cockenzie, has taken over the business of R. Thompson & Company, engineers, etc., 46, Sandport Street, and Ronaldson's Wharf, Leith, of which Mr. T. R. T. Thompson was the sole proprietor.

Messrs. W. Christie & Company, 50, Wellington Street, Glasgow, have removed to 105, St. Vincent Street, Glasgow. Messrs. Christie are agents for H. H. Vivian & Company, Limited, Henry Watson & Sons, and W. L. Byers & Company, Limited.

Mr. J. Fry, of Messrs. Hallett & Fry, antimony refiners, 202, Rotherhithe Street, London, S.E., has started business on his own account as a metal refiner under the style of Fry's Metal Foundry, 25 and 27, Holland Street, Blackfriars, London, S.E.

Considerable damage was done by fire, on May 27, to the Castle Engineering Works, Berwick, occupied by Messrs. M'Bain Brothers. The fire originated in the engine-room, and in the course of an hour the buildings, which form a large oblong block, were entirely gutted.

Messrs. A. Smith and H. W. Shaw, carrying on business as consulting engineers and manufacturers' agents, at Victoria Buildings, Corporation Street, Birmingham, under the style of Arnold Smith, Shaw & Company, have dissolved partnership.

The estates of J. R. Davidson & Company, engineers, etc., 116, Hope Street, Glasgow, and J. R. Davidson, the sole partner, have been sequestrated by the Sheriff of Lanarkshire, at Glasgow. Claims must be lodged by September 22. Mr. J. Allison, junr., 133, St. Vincent Street, Glasgow, has been elected trustee.

Mr. Philip S. Doherty has severed his connection with the Worthington Pump Company, Limited, and has started as an engineer and agent on his own account at 25, Victoria Street, Westminster, London, S.W., representing, amongst others, the Eureka Pump Company, of Christiania.

The members of the Newcastle and District Branch of the British Foundrymen's Association will visit the Tees Iron Works of Pease & Partners, Limited, on July 20 next. The members availing themselves of this opportunity will also visit the new transporter bridge, docks, etc., at Middlesbrough.

The firm of Arrol & Macgillivray, general engineers, 10, Morrison Street, South Side, Glasgow, of which Mr. James Arrol and Mr. Samuel Macgillivray were the partners, has been dissolved by mutual consent by the retirement of the latter. Mr. Arrol will continue the business under the same name.

At a general meeting of the shareholders of David Richmond & Company, Limited, tube manufacturers, Glasgow, held on the 22nd ult., a resolution was passed to the effect that the company be wound up voluntarily, and that Mr. J. Taylor, 24, George Square, Glasgow, be appointed liquidator.

The Vincit Company, Limited, 70, Queen Victoria Street, London, E.C., inform us that in future the business will be carried on under the title of the United Carborundum and Electrite Works, Limited (The Vincit Company, Limited). The Company will continue to manufacture their two specialities in abrasive materials, viz., carborundum and electrite.

A meeting of the members of the Stassano Electro Flex Steel and Furnace Company, Limited, will be held at the offices of W. & W. Stocken, 49, Leadenhall Street, London, E.C., on Friday, July 19, for the purpose of having an account laid before them showing the manner in which the winding-up of the company has been conducted and the property disposed of.

The partnership heretofore subsisting between Messrs. H. Williams and F. Williams, carrying on business as engineers at Red Lion Yard, Warner Street, Rosebery Avenue, London, E.C., under the style of H. Williams & Company, has been dissolved. The business will be carried on in future by Mr. H. Williams, under the present style of H. Williams & Company.

The Appleby Ironworks, Scunthorpe, Lincs., of the Appleby Iron Company, Limited, which have been standing since the recent strike, have been purchased by the Frodingham Iron and Steel Company, Limited, who will probably have them working again this month. There are four blast furnaces of a capacity of 600 tons per furnace per week.

An announcement was made in Bolton, on May 25, that the Victoria Foundry, belonging to Messrs. J. & E. Wood, Bolton, was to be closed. For some years, it was explained, the firm has been working on unremunerative terms in consequence of the keenness of competition, both at home and abroad. No financial difficulties exist, but for the reason stated the business will be discontinued.

At a meeting of the shareholders of John Wilson & Son (Johnstone), Limited, engineers, Johnstone, held on May 29, a resolution was passed to the effect that it had been proved to the satisfaction of the company that it could not by reason of its liabilities continue its business, and that the company be wound up, and, further, that Mr. William McLintock, 149, West George Street, Glasgow, be appointed liquidator.

On May 31, at the Station Hotel, Newcastle, by order of the receiver for the debenture holders, Messrs. Wheatley, Kirk, Price & Company offered for sale by auction the extensive works of Ernest Scott & Mountain,

Limited, at Gateshead, in one lot as a going concern. Mr. H. Sherley-Price enumerated the conditions of sale and the features of the works and the business done there. The land was freehold 6¾ acres, and the shops were level and served by railway sidings. Bidding commenced at £25,000 and went up to £39,000, at which the concern was withdrawn.

J. W. JACKMAN & COMPANY, LIMITED, have now transferred the Manchester branch of their business from Chester Road, Cornbrook, to their new works in Blackfriars Road. The equipment of the Vulcan Works will constitute a distinct departure, as the main shop will be laid down with an extensive range of tools and labour-saving devices for the foundry, and these will be shown in actual operation. The working plant will include hydraulic and pneumatic tools in variety, whilst the installation of sand-blast apparatus of various forms will be amongst the most comprehensive in this country.

THE foundry supplies business of Murphy & Company, 54, Rosebery Avenue, E.C., is now being carried on under the style of Murphy, Stedman & Company, Limited, Gamage Buildings, Holborn, E.C., and covers foundry requisites and machinery, and general plant. The firm are the representatives in London and South of England for the following firms:—The Adaptable Moulding Machine Company, moulding machines; Durrans & Sons, foundry blackings; Moor & Sons, general requisities; Derby Boiler Company, ladles, cupolas, etc.; and Woodwards Patent Foundry Lamp.

ARRANGEMENTS are already in hand for the visit of the Iron and Steel Institute to Leeds on October 1, 2, and 3. At a meeting of gentlemen interested held in Leeds, on June 15, an Executive Committee was appointed to draw up the programme. Lord Airedale was elected chairman, and Mr. Rupert Beckett hon. treasurer. The secretarial duties will be discharged by Mr. Walker, the Lord Mayor's secretary. Among the entertainments to be given in honour of the visitors there will probably be a reception by the Lord Mayor (Mr. William Nicholson), another at the University, and a garden party at Gledhow Hall, given by Lord Airedale.

THE Secretary of State for India has appointed a Committee to inquire and report as to the facilities available for Indian students for industrial and technological training in this country, with special reference to the system of State Technical Scholarships established by the Government of India in 1904. The Committee is constituted as follows:—Sir Theodore Morison, K.C.I.E. (Chairman), and Sir Krishna Gupta, K.C.S.I., Members of the Council of India; Mr. J. H. Reynolds, M.Sc., lately Principal of the Municipal School of Technology at Manchester; and Professor W. E. Dalby, M.A., Professor of Civil and Mechanical Engineering at the Imperial College of Science and Technology at South Kensington. The Secretary to the Committee is Mr. P. H. Dumbell, of the India Office.

DURING a lengthy discussion on the Insurance Act at a recent meeting of the Leeds Chamber of Commerce, Mr. John Maclaren, president of the Leeds and District Engineering Employers' Association, said that so far as the engineering employers of the city were concerned, they were going to try loyally to carry out the law and make the Act as much a success as it might be. He could not, however, say the same of the workpeople. He had heard nothing but unfriendly criticism from them, and he would not be surprised if there was some difficulty in getting workmen to apply for the necessary employment books. Employers would then be on the horns of a dilemma. As far as he could see, if the workman did not give the employer an employment-book, the latter, in order to save himself, would have to discharge the workman.

THE provisional programme has just been issued by the Cornwall Joint Scientific Reception Committee of the visit of learned and technical societies to Cornwall, which takes place from July 16 to 20. On the opening day the party will journey to Camborne and visit the engineering works of Messrs. Holman Bros., including the Dolcoath Mine, and the mine and tin-dressing plant. On July 17 the party will visit the various clay properties in East Cornwall, and the 18th will be occupied by a trip to Truro and Falmouth, including a visit to the Royal Institution of Cornwall. On July 19 Camborne will again be the destination of the party, the mining schools, and King Edward Mine, or South Crofty Mine, and Messrs. Stephens' Rock Drill Works being visited, while the concluding day will be devoted to a reception by the Royal Geological Society at Penzance, and a visit to the St. Ives Consolidated Mines.

NEW works are now in course of erection at Broadheath for the firm of Geo. Richards & Company, Limited, machine tool builders, Broadheath, near Manchester. The new works adjoin their present extensive works, and are being built upon a site covering ten acres of land. The building, which will be a machine and erecting shop, is 260 ft. wide and 250 ft. long, and comprises one centre bay 50 ft. wide and 60 ft. high, two bays 40 ft. wide, two bays 25 ft. wide and four bays 20 ft. wide, two of the latter being two storey. It is capable of extension to double the length named. It will be equipped in the most modern way, and possess every facility for the rapid production of the firm's manufactures, due regard also being paid to those conditions necessary for the convenience and good health of the employees. The works will be driven and lighted electrically, and the most modern system of heating and ventilating plant introduced. Jib, hand and electrically-driven cranes to lift material up to 30 tons weight are being installed, and railway tracks will be laid down both inside and around the works for the rapid and easy handling of goods. The works will not only be used for the manufacture of machine tools, but also for air-compressors. Upon completion of these works the erection of a new foundry, 130 ft. wide by 250 ft. long, is to be commenced.

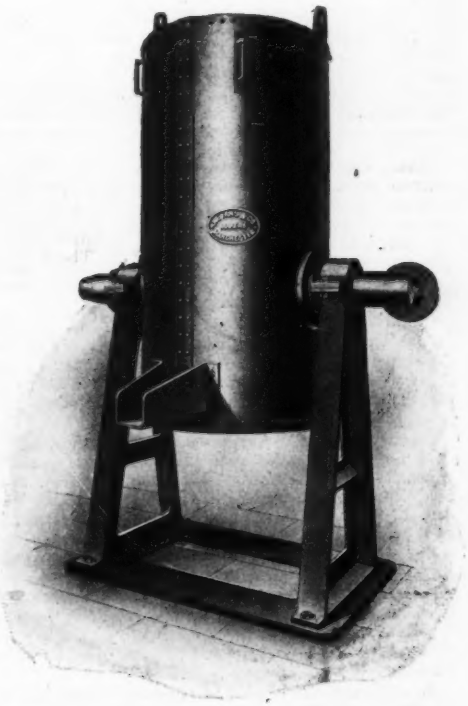
AT a meeting of the Council of the Walsall and District Chamber of Commerce recently, Mr. J. Hemming presided, and mentioned that in view of the fact that the National Insurance Act would come into operation in a few weeks the special National Insurance Committee of the Chamber had held several meetings in furtherance of the proposal that employers and workpeople should continue the works clubs' and also form new ones, and should get them recognised as approved societies. With regard to the unemployment section of the Act, he had received from the Insurance Commissioners a series of papers of considerable interest to Walsall manufacturers, as they showed that ironfounding in all its branches was included in the list of trades scheduled for the purpose of the Act. He was not prepared to make a positive statement that the whole of the workpeople engaged in the ironfounding trade would be entitled to unemployment benefit, but manufacturers engaged in that trade would no doubt take the necessary steps to satisfy themselves on the point. It was an important matter, as employers would have to keep entered up weekly an unemployment-book for each of their workpeople. Mr. C. F. Hurst said a list of workpeople given in the Act appeared to cover all classes in the ironfounding trade except "barrelers," though it was possible they also were meant to be covered by some other definition. Mr. T. A. Smith said the papers referred to by the President had also been sent to local firms, and they appeared to make it clear that all the ironfounders and casters of the town came under the unemployment section. This was quite unforeseen, and would double the contributions manufacturers would have to pay and also the labour entailed in book-keeping. It meant that manufacturers would have to pay 6d. weekly for every employé, and as profits were not any too large already it was a serious addition to the cost of production. His firm would have a set of 600 unemployment books to keep entered up. Mr. Creswell suggested that Chambers of Commerce should call meetings and refuse to carry out the Act, but the President said they must recognise that the measure was now the law of the country. It was decided to convene a meeting of all members of the Chamber likely to be affected by the unemployment section and to ask a representative of the Insurance Commissioners to attend.

AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.



James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

New Companies.

METAL MOULD COMPANY, LIMITED.—Capital £1,000 in £1 shares (500 cumulative preference).

MURPHY, STEDMAN & COMPANY, LIMITED.—Capital £1,250 in £1 shares, to carry on the business of foundry engineers, etc.

UNITED CARBORUNDUM AND ELECTRITE WORKS, LIMITED.—Capital £100 in £1 shares. Registered office: 70, Queen Victoria Street, E.C.

H. C. HARVEY, LIMITED.—Capital £100 in 2s. shares, to carry on the business of founders. Registered office: 10, Union Passage, Birmingham.

THE SUPER HEAT FURNACE COMPANY, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers, etc.

MARINE AND GENERAL OIL ENGINES, LIMITED.—Capital £5,000 in 4,750 shares of £1 and 5,000 of 1s. Registered office: Caxton House, Tothill Street, Westminster.

F. SHAW (SALFORD), LIMITED.—Capital £500 in £1 shares, to carry on the business of iron and brass founders, etc. Registered office: 9, Wroe Street, Salford.

PINFOLD & PARR, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of engineers, etc. Registered office: Dunston Works, 11A, Deritend Bridge, Birmingham.

SAUNDERS, TODD & COMPANY, LIMITED.—Capital £7,000 in £1 shares, to carry on the business of engineers' manufacturers and general agents, merchants, metal merchants, etc. Registered office: Maritime Buildings, King Street, Newcastle-on-Tyne.

NAVALTUM, LIMITED.—Capital £75,000 in £1 shares, to carry on the business of machine and engineering tool makers, etc., and to acquire all rights in a certain existing invention relating to aluminium or aluminium alloy. Registered office: Worcester House, Walbrook, E.C.

JOHN F. HARDAKER, LIMITED.—Capital £15,000 in £1 shares (4,500 6 per cent. cum. pref., 4,300 ordinary, and the balance unclassified), to take over the business of a machine maker formerly carried on by Mr. J. T. Hardaker as John T. Hardaker, at Osborne Street, Bradford.

JOHN BLAIKIE & SONS, LIMITED.—Capital £10,000 in £1 shares, to acquire and take over as a going concern the business of bell and brass founders, electrical engineers, etc., now carried on at Aberdeen under the name of John Blaikie & Sons. Registered office: 10, Bow Accord Street, Aberdeen.

GEAR GRINDING COMPANY, LIMITED.—Capital £50,000 in £1 shares, to carry on the business of dealers in grinding machines and component parts thereof, grinders of gears and other articles, etc., and to adopt an agreement with the Gear Grinding Machine Company, of Detroit, Michigan, U.S.A.

JAMES SHENTON & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to take over the business of general and consulting engineers, iron and brass founders, etc., carried on by J. Shenton, J. W. Shenton, B. P. Shenton, and F. Williams, as James Shenton & Company, Edison Works, Tinsley Street, Great Bridge, Staffs.

FLEET BRASS COMPANY, LIMITED.—Capital £3,000 in £1 shares (610 preference), to adopt an agreement with A. Raybould and S. Huxley for the acquisition of the business of brassfounders, etc., carried on by them at 9 and 11, Fleet Street, Birmingham, as the Fleet Brass Company. Registered office: 9 and 11, Fleet Street, Birmingham.

SCUNTHORPE FOUNDRY COMPANY, LIMITED.—Capital £4,000 in £1 shares, to take over the business of the Scunthorpe Foundry Company, Limited, lately carried on at Scunthorpe, Lincs., by M. Buckley, as receiver in a partnership winding up, and to carry on the business of iron smelters, founders and dealers, etc. Registered office: Dawes Lane, Scunthorpe, Lincs.

DEATH & ELLWOOD, LIMITED.—Capital £15,000 in £1 shares (5,000 cumulative preference). Objects to take over the businesses (1) of ironfounders and engineers carried on at Joseph Street and Clarendon Street, Leicester, as Death & Ellwood; and (2) of an engineer carried on by A. Gamble, at Millstone Lane, Leicester, as A. Gamble & Company, and to adopt an agreement with H. Raven and F. J. Hill.

A. W. WILLS, LIMITED.—Capital £80,000 in 40,000 6 per cent. cumulative preference and 39,950 ordinary shares of £1 each, and 1,000 employes' shares of 1s. each, to carry on the business of edge and other tool makers, etc., and to acquire the business carried on by E. M. Sage, at Park Mills and San Paulo Works, Nechells, Birmingham, as A. W. Wills & Son. Registered office: Park Mills, Nechells, Birmingham.

Deaths.

MR. J. H. WILKINSON, assistant managing director of Wm. Cooke & Company, Limited, of Tinsley, Sheffield, was found drowned in a pond on the works premises on June 19. It is not known how he got into the water. He was at the works as usual early on the 18th, but was missed shortly afterwards.

WE regret to announce the death of Mr. William Robinson, who was for so many years associated with the firm of William Jessop & Sons, Limited, of Sheffield, which occurred at Sheffield on May 28 after a very short illness. This news will be received with very great regret by a large circle of friends in the iron and steel industries throughout the country.

THE death is announced, at Southport, under extremely distressing circumstances, of Mr. M. W. Counsell, who was well known in iron and steel circles in Lancashire. He had held positions with several leading firms in the North of England, including Messrs. John Needham & Sons, of Manchester, Messrs. Samuel Osborne & Company, of Sheffield, and Messrs. George Bradshaw & Company, of Manchester. The deceased gentleman was the popular acting honorary secretary of the Manchester and District Iron and Steel and Allied Trades Bowling Club. He was 41 years of age.

MR. M. W. SWINBURNE died recently at his residence, The Cottage, Jesmond Park East, Newcastle. The deceased gentleman served his apprenticeship as an engineer with Messrs. W. G. Armstrong & Company, Elswick Works, now Sir W. G. Armstrong, Whitworth & Company, Limited, and subsequently he became manager for Messrs. Henry Watson & Sons, High Bridge, Newcastle. Twenty-five years he spent in that position, and twenty-one years ago he commenced business for himself at Wallsend. The firm of Messrs. M. W. Swinburne & Sons, engineers, brassfounders, and coppersmiths is well-known all over the country. They now employ over 200 men, and make a speciality of brass work for ships and marine engines. Mr. Swinburne was a member of the Institution of Mechanical Engineers, an associate member of the Institute of Naval Architects, and a member of the North-East Coast Institution of Engineers and Shipbuilders.

MR. T. B. MATTHEWS, of Sheffield, died suddenly on June 2. Although for over 20 years Mr. Matthews had resided at Thorpearch Hall, Boston Spa, Harrogate, he was a member of an old Sheffield family and well-known in the city. He was the son of a Mr. W. A. Matthews, who was Mayor of Sheffield and Master Cutler in the year 1852-3. His father was taken into the firm of Messrs. Thomas Turton & Sons, Sheaf Works, and he took a leading part in that concern until his death. When the business of Thomas Turton & Son passed into the hands of the late Sir Frederick Mappin, the sons of Mr. W. A. Matthews took over the works at Neepsend, which became Messrs. Turton Brothers & Matthews, Limited, steel and file manufacturers, and of this Mr. T. B. Matthews became the head. Until he left Sheffield he took an active interest in the business, and even after he left the city and went to reside at Harrogate, he kept in the closest touch with the firm until a few years ago.

PURE METALS

and ALLOYS. FREE from CARBON.

TITANIUM THERMIT

for

SOUND, STRONG, CLOSE-GRAINED CASTINGS.

Also FERRO VANADIUM and FERRO TITANIUM.

Full Particulars and PRICES from—

THERMIT LIMITED

Telegrams: "Fulmen, London." 27, Martins Lane,

Telephone: 3749 Central, Cannon Street, E.C.

Works: 210a, Bow Road, E.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

METALS.	End June, 1912.	End June, 1911.
Iron—Scotch pig warrants ton	.... *62/9	.... *52/3
—Middlesbro' warrants . ton	.... 56/11½	.... 46/4
—W.C. M/nos Bessemer ... ton	.... 73/6	.... 63/0
—Stock, Scotch ... ...tons	 1,000	 1,000
Copper—Chili bars, GMB ton	.... £78 7 6	.... £57 0 0
—Stock, Europe and afloat tons	.... —	.... —
Tin—English ingots ... ton	.... £212 0 0	.... £196 10 0
—Straits ... ... ton	.... £208 5 0	.... £197 5 0
—Stock, London, Holland, U.S.A., and afloat ...tons	.... —	.... —
Lead—English pig ... ton	.... £18 7 6	.... £13 15 0
Spelter—Ord. Silesian ... ton	.... £25 17 6	.... £24 15 0
Quicksilver (75lb)... bottle	.... £8 0 0	.... £8 7 6
Antimony—Regulus ... ton	£27 0 0 £28 0 0	.... £29 10 0
Aluminium—Ingot ... ton	.... £80 0 0	

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 7 6	to	5 15 0
,, 3 to 4 in.	5 2 6	to	5 5 0
,, 5 to 8 in.	5 0 0	to	5 2 6
,, 10 to 16 in.	5 0 0	to	5 2 6
,, 18 to 24 in.	5 0 0	to	5 2 6
Chairs	3 17 6	to	4 0 0
Floor plates (open sand)	3 7 6	to	3 10 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 5s. 0d.; heavy cast, £2 10s. 0d.; all per ton, f.o.b., London. Copper (clean), £69 10s. 0d.; brass (clean), £45 10s. 0d.; lead (usual draft), £16 15s. 0d.; zinc, £20 10s. 0d.; all per ton delivered merchant's yard.

Personal.

THE late Mr. W. Thomlinson-Walker, of the Victoria Ironworks, York, left estate of the gross value of £12,000.

MR. C. STANLEY MARTIN, late general manager of Messrs. Cammell, Laird & Company's Derwent Works at Workington, has been appointed general superintendent of the Dominion Iron and Steel Company, Sydney, Nova Scotia.

MR. H. HARLAND, a nephew of the late Sir Edward Harland, has been appointed to be head of the designing department of Harland & Wolff, Limited. The vacancy was created through the death of Mr. Thomas Andrews, who was one of the victims of the "Titanic" disaster.

MR. ANDREW REASON, who for upwards of 26 years has been connected with Hick, Hargreaves & Company, Limited, Soho Iron Works, Bolton, is now taking over the active management of the Ideal Covering Company, Limited, 158 & 160, Crook Street, Bolton, of which he is managing director.

MR. W. J. GUY, of Sheffield, has been appointed manager of the Newburn Steel Works, Newcastle-on-Tyne, of John Spencer & Sons, Limited, in succession to Mr. W. E. Hampton, who has removed to Birmingham. Mr. Guy has been associated with John Brown & Company, Limited, of Sheffield and Clydebank, for over 10 years.

MR. W. R. BATES, general manager of Messrs. James Oakes & Company's Alfreton Ironworks, Derbyshire, was married on June 12 to Miss E. L. Hutchinson, daughter of Mr. John Hutchinson, iron merchant, Cardiff. Mr. Bates was on Monday the recipient of a presentation, subscribed for by the agents, staff and officials of the Company.

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THE
IRON CEMENT
(Quick or slow setting grades)
IS
THE CHEAPEST
AND
MOST RELIABLE
for all purposes.
Unaffected by oil, steam, or water.

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GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

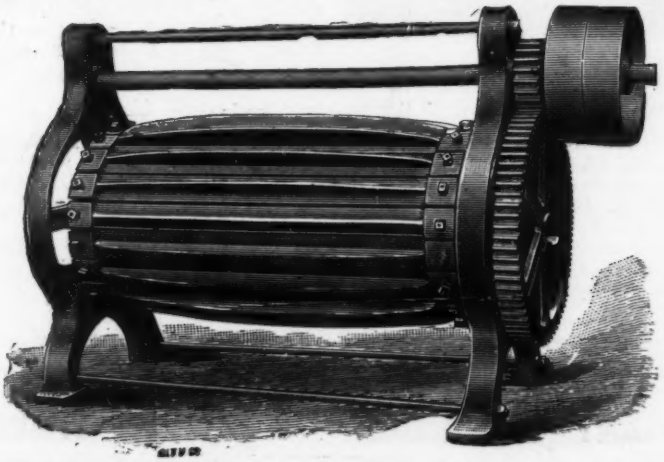
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Plate Moulding with Snap Flasks . .

is used extensively for dealing with light castings in all departments of the foundry trade. It is without question a very rapid method of moulding, and taken in conjunction with the fact that the snap flask does away with moulding boxes it is not surprising that the system is growing in favour. In point of output many power Moulding Machines can show an advantage over plate moulding, but this is over-balanced by the cost of the necessary boxes, the maintenance expenses and the floor space required for storing them.

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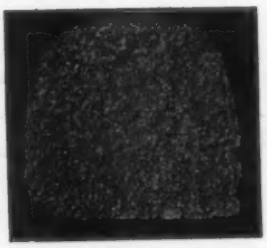
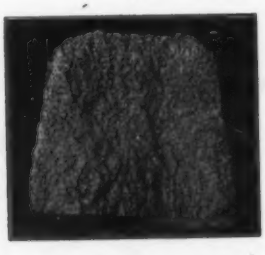

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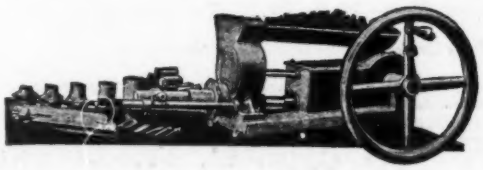

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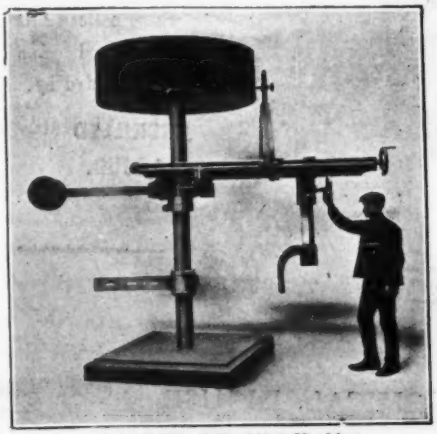

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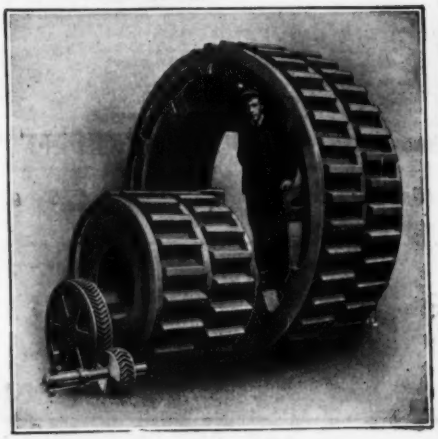

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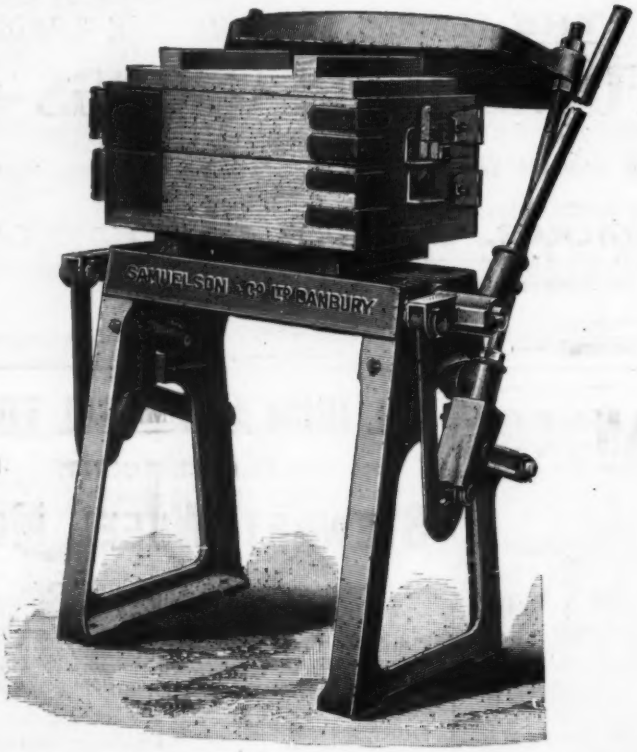

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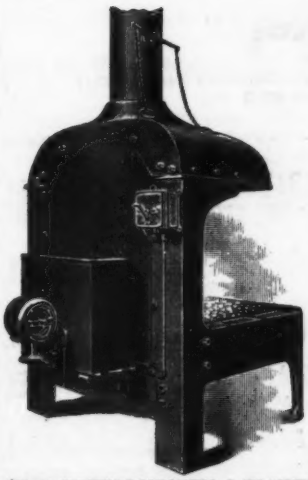

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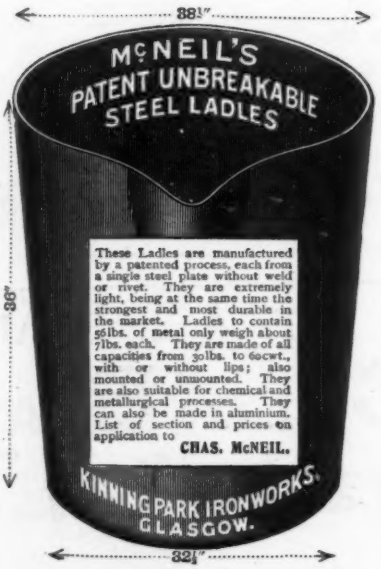
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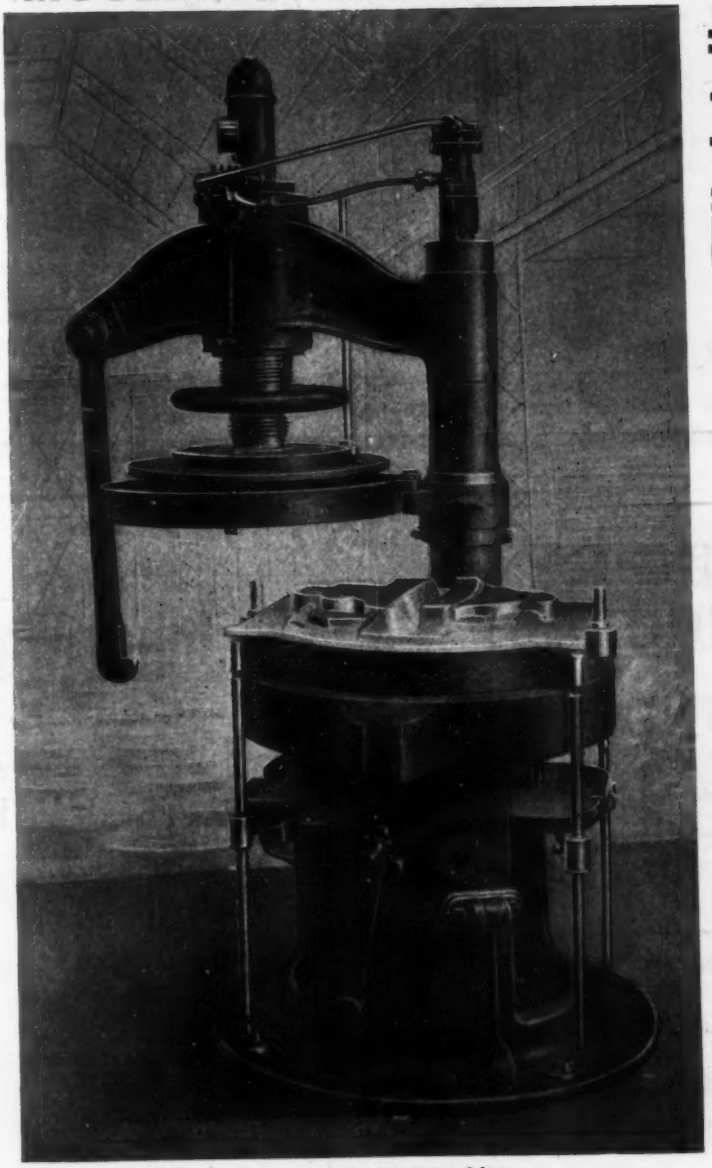

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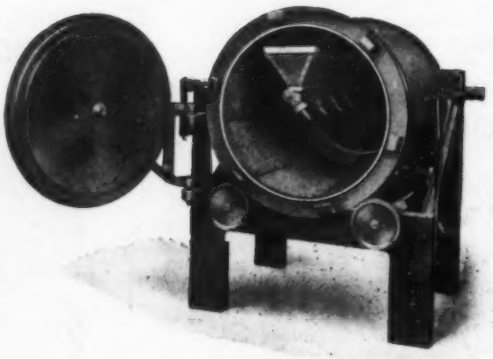

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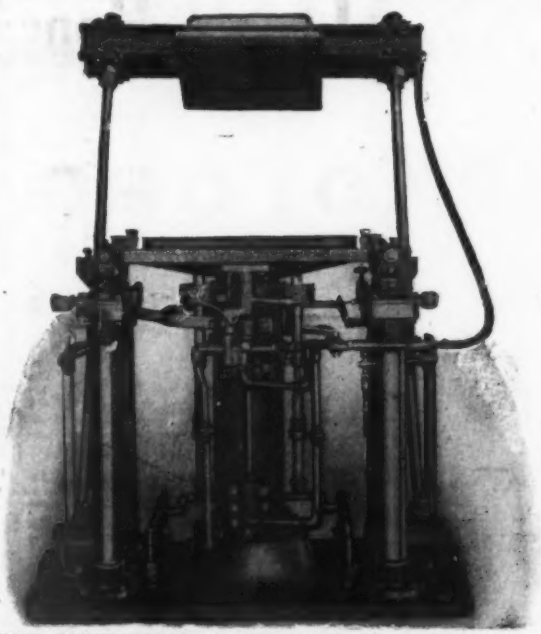

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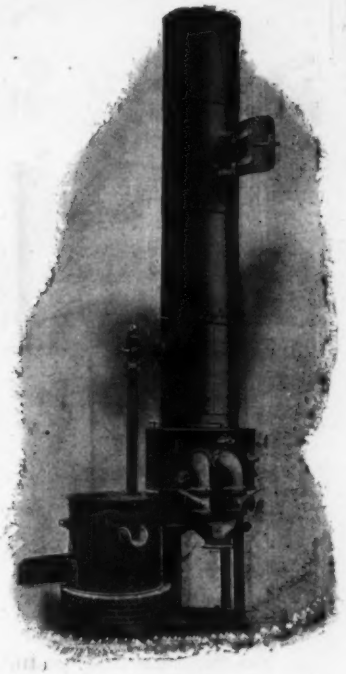

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